THE ENGINEER

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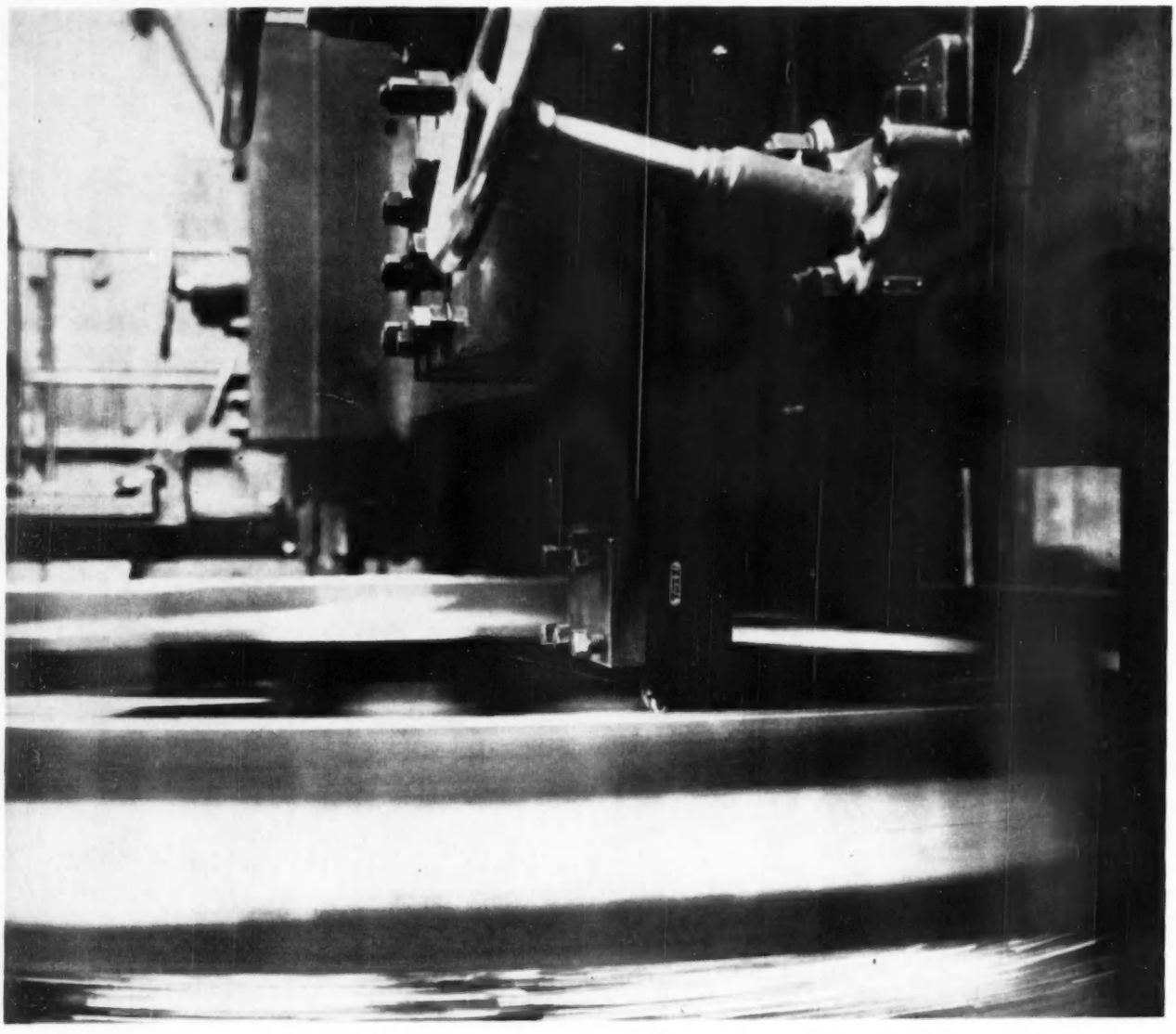

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THE ENGINEER

Established 1856

No. 5474 **DECEMBER 23, 1960** VOL. 210

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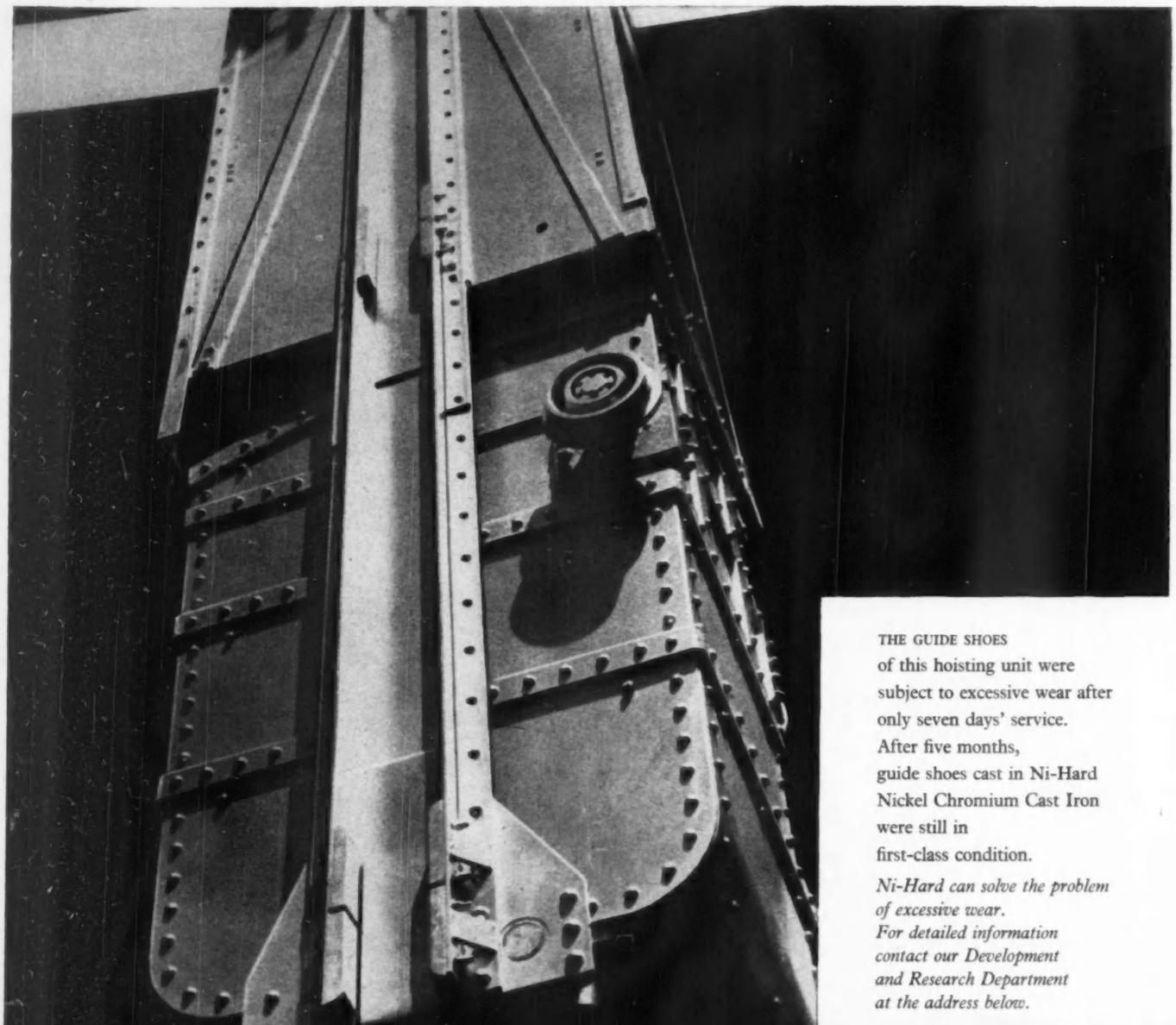

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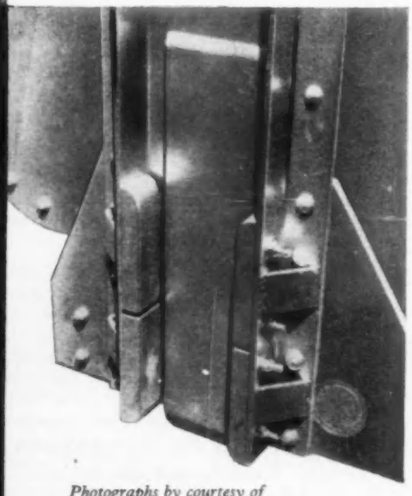

Photographs by courtesy of Wabi Iron Works Ltd, Ontario show how guide shoes were fitted.

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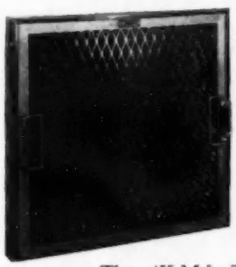

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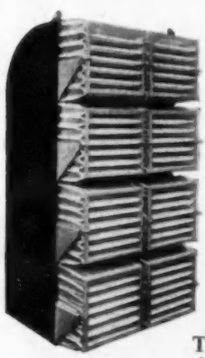

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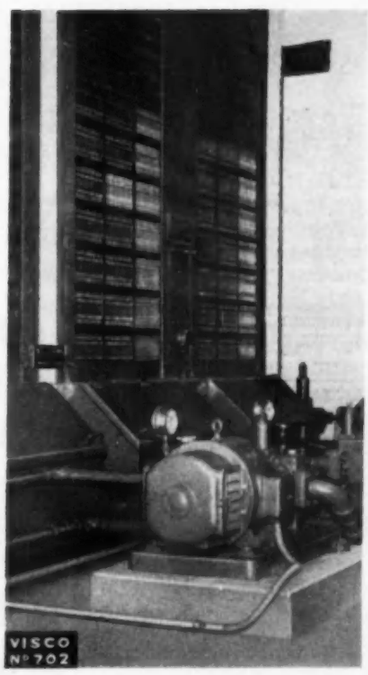

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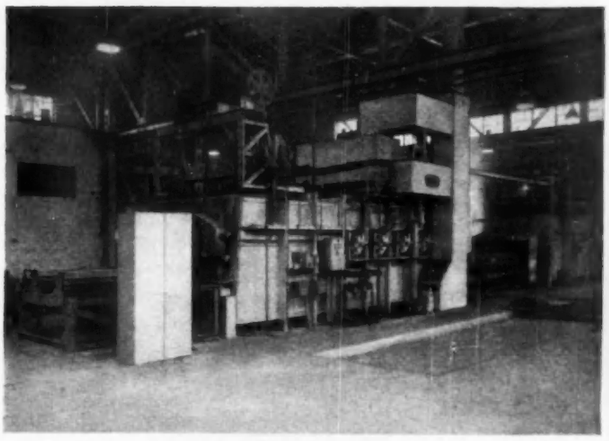

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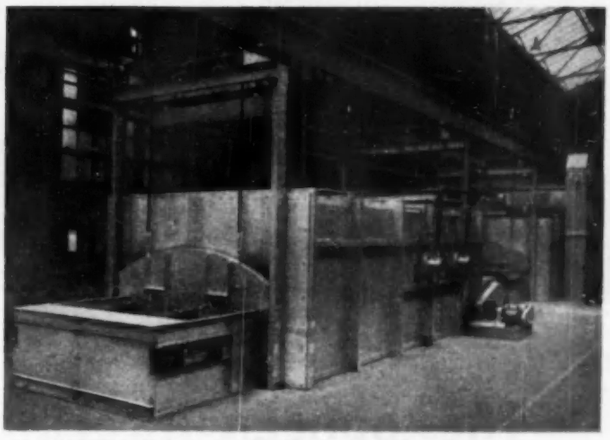

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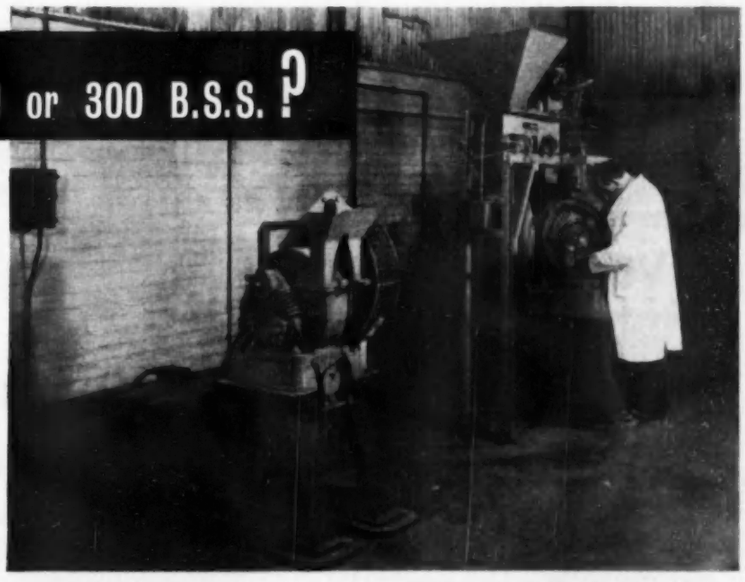

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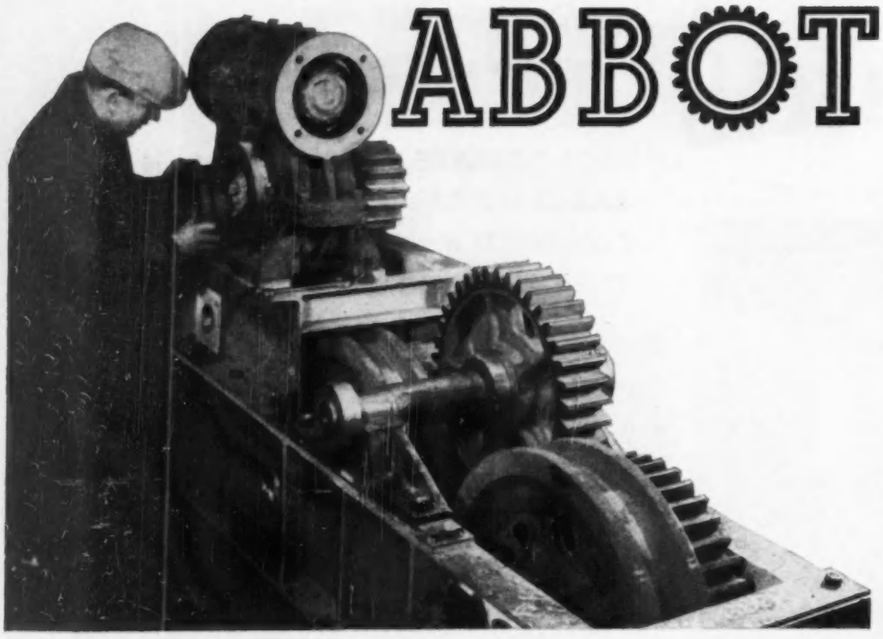

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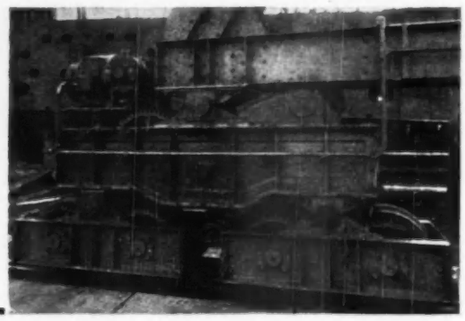

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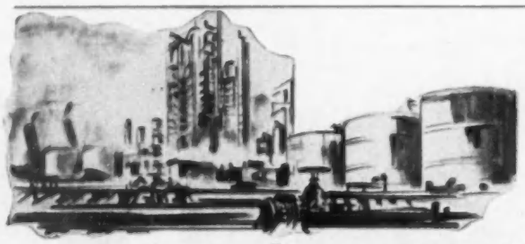

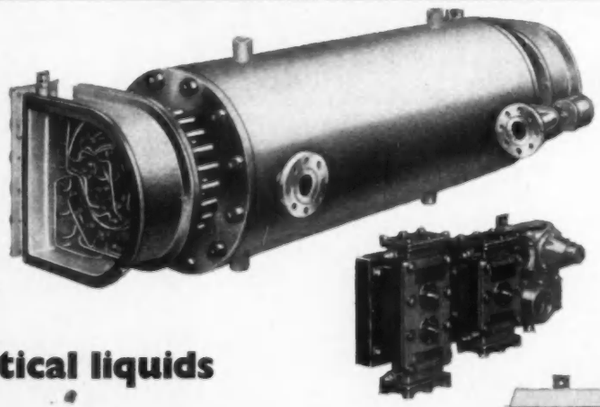

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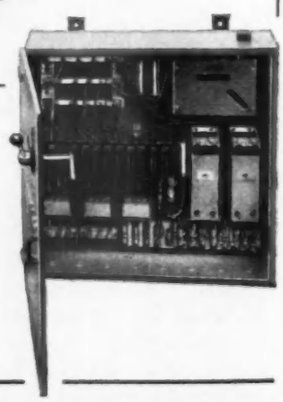

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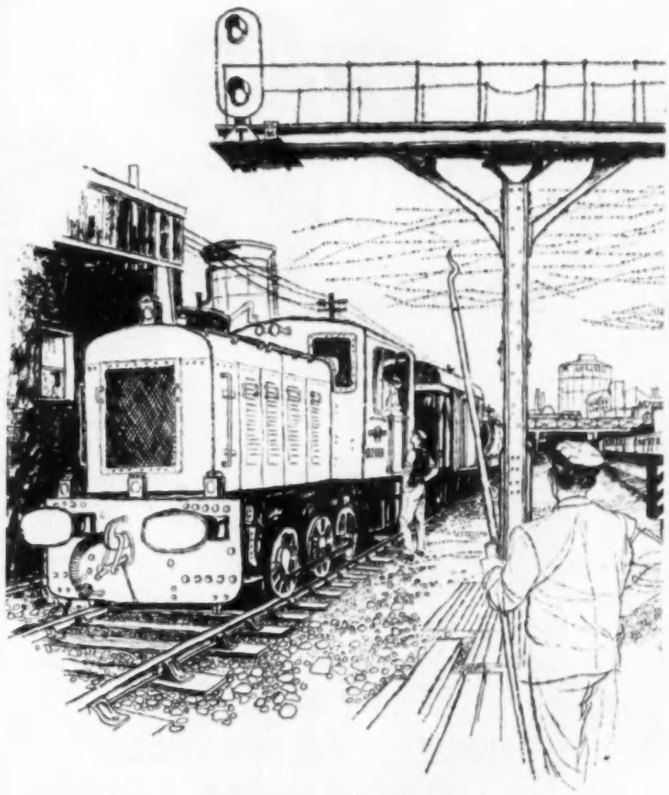

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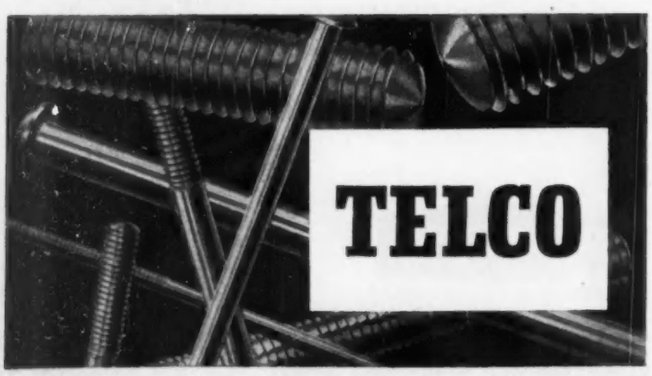

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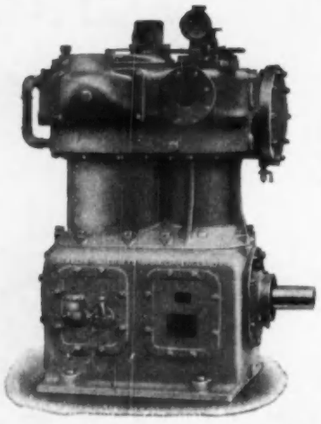

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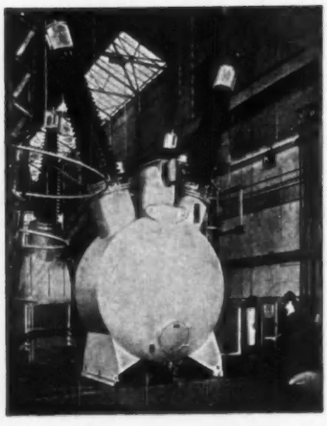

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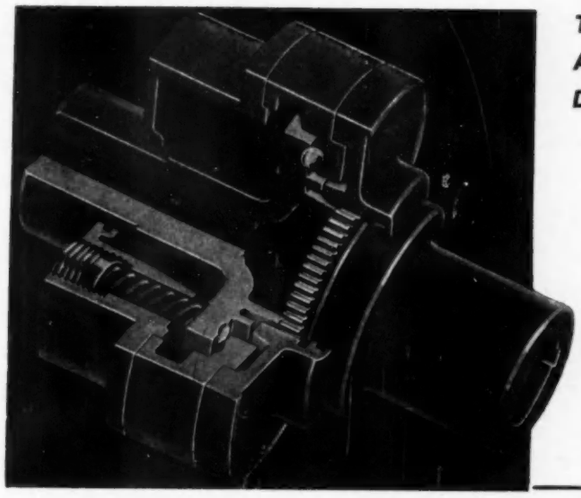

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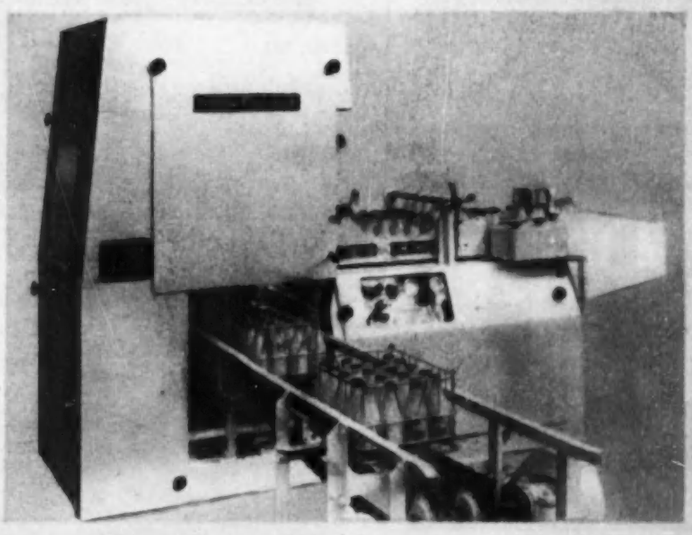

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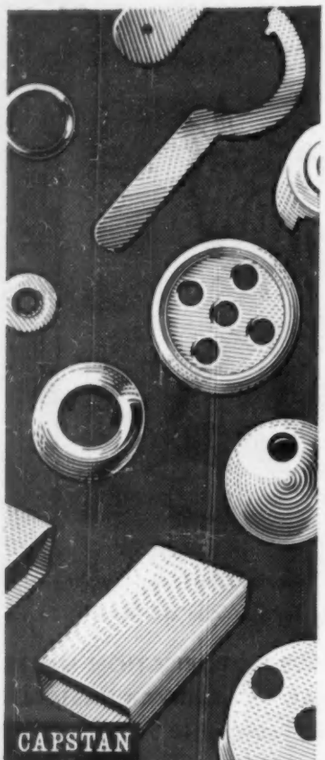

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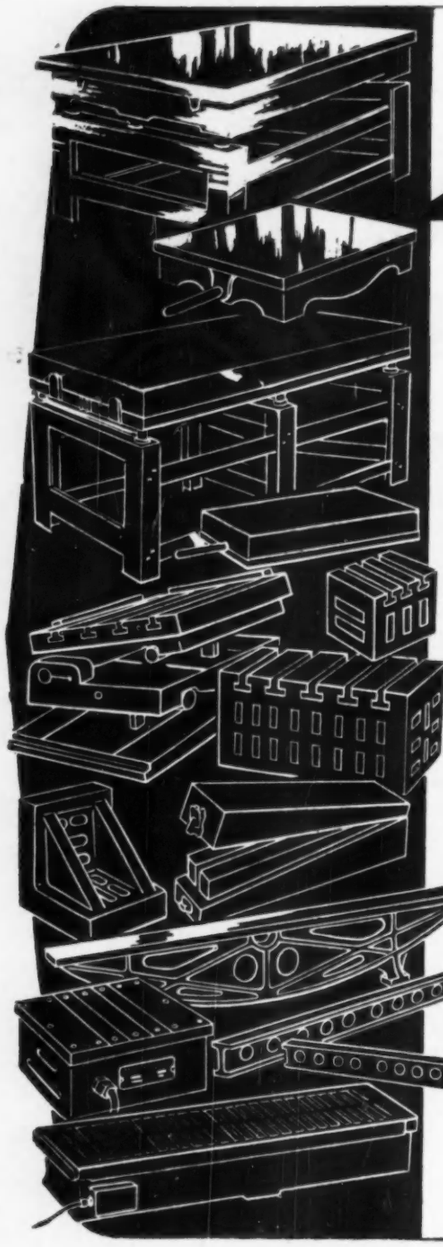

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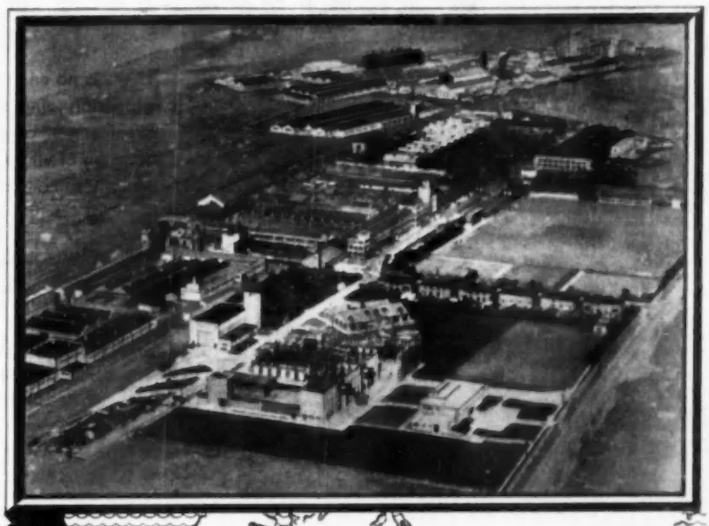

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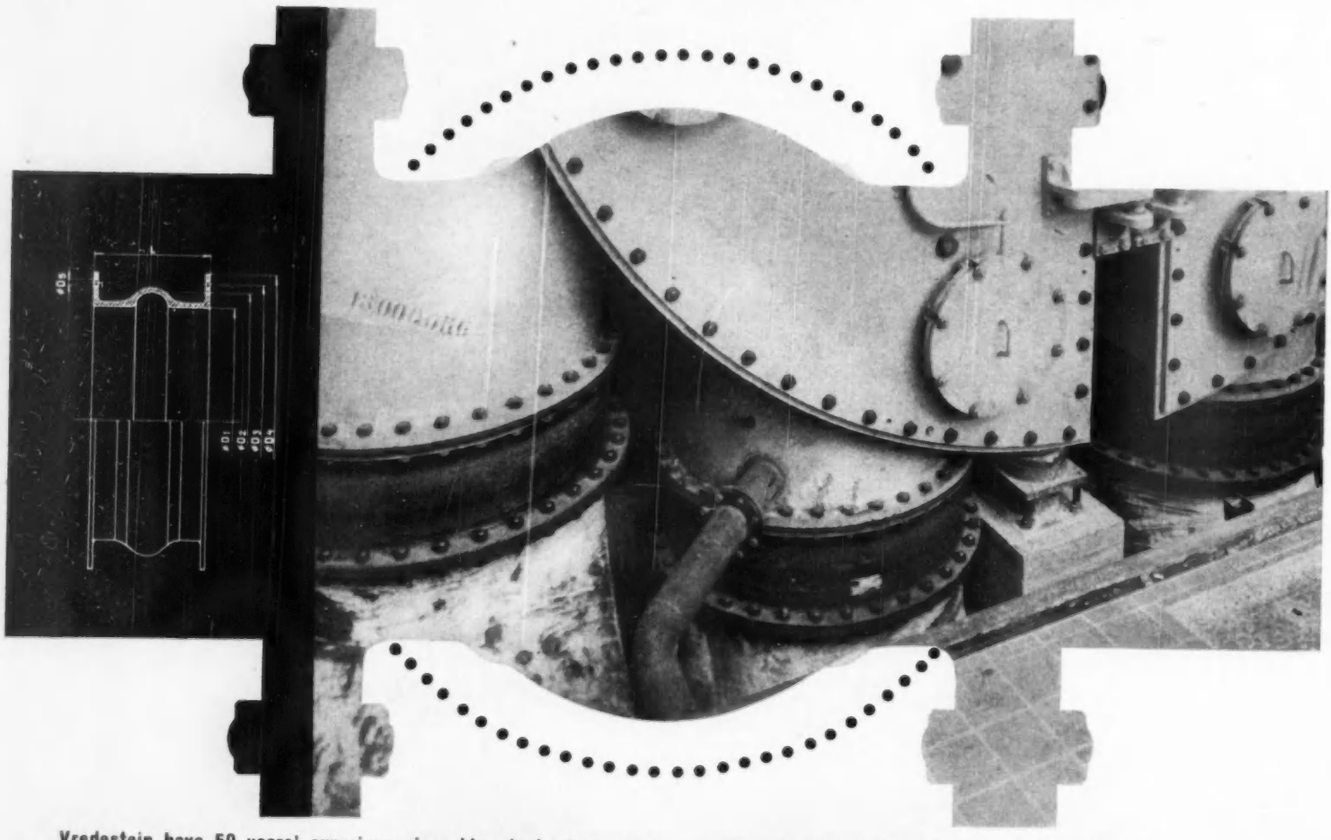

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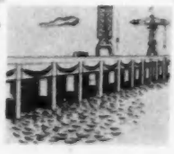

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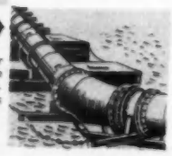

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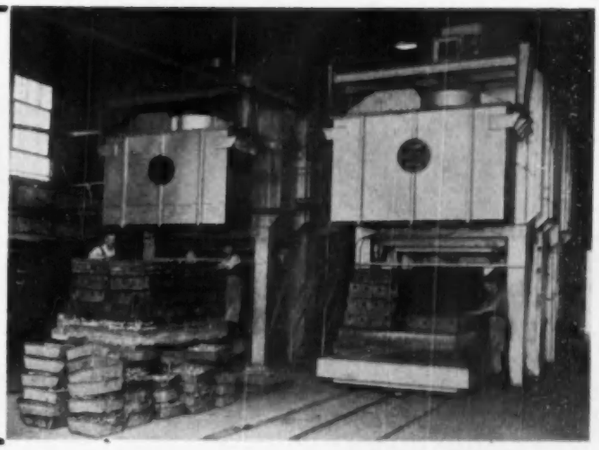

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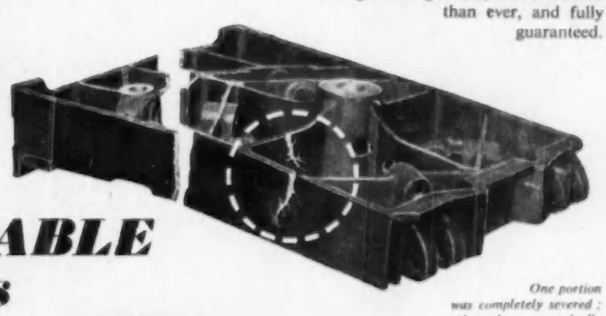

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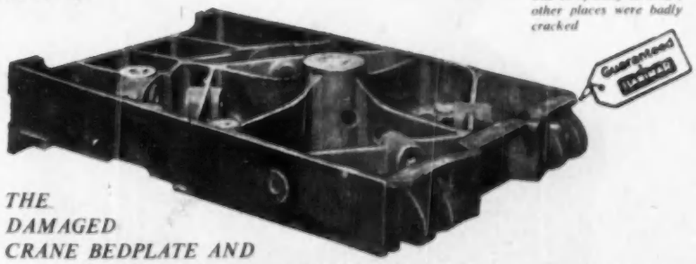

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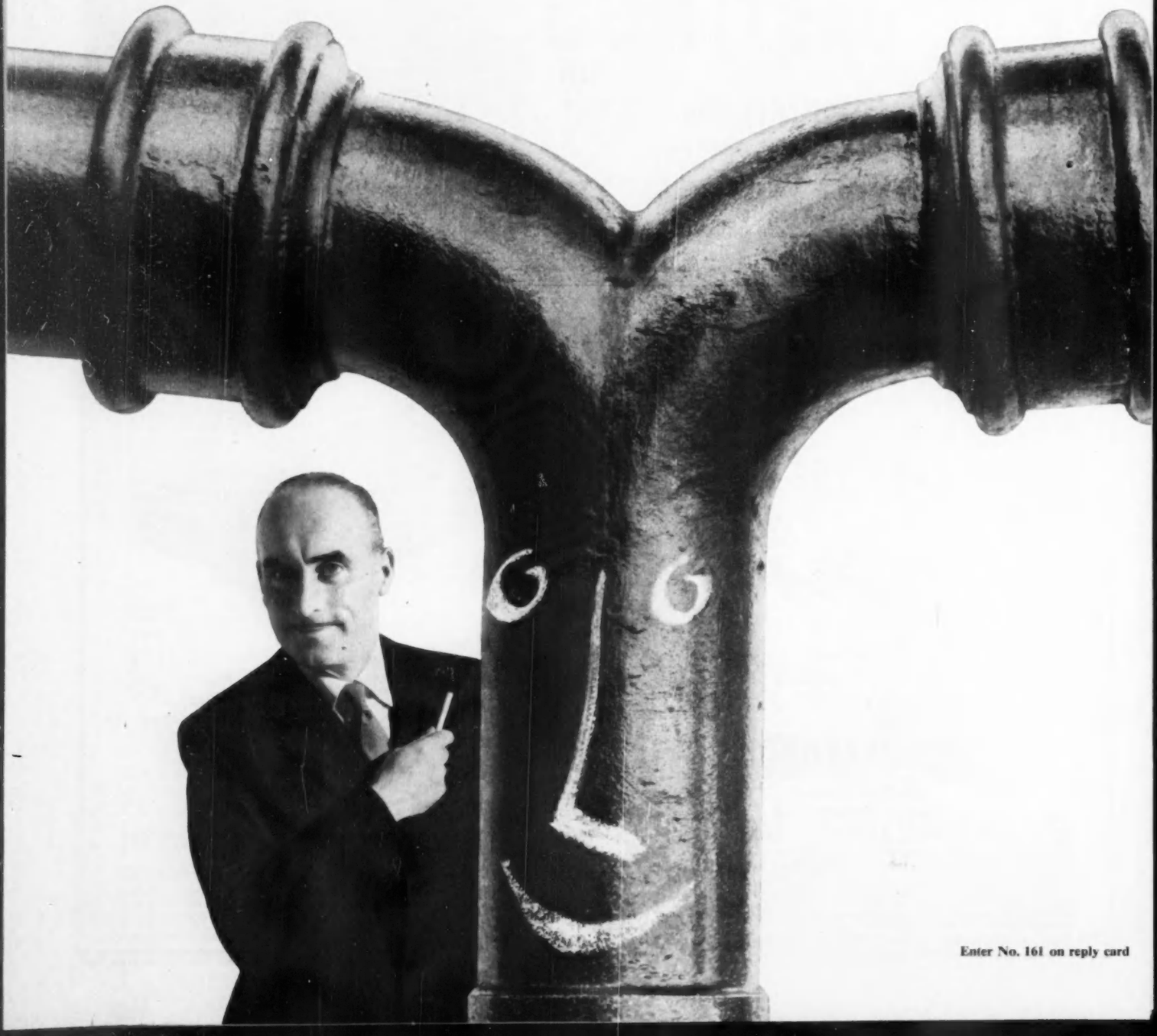

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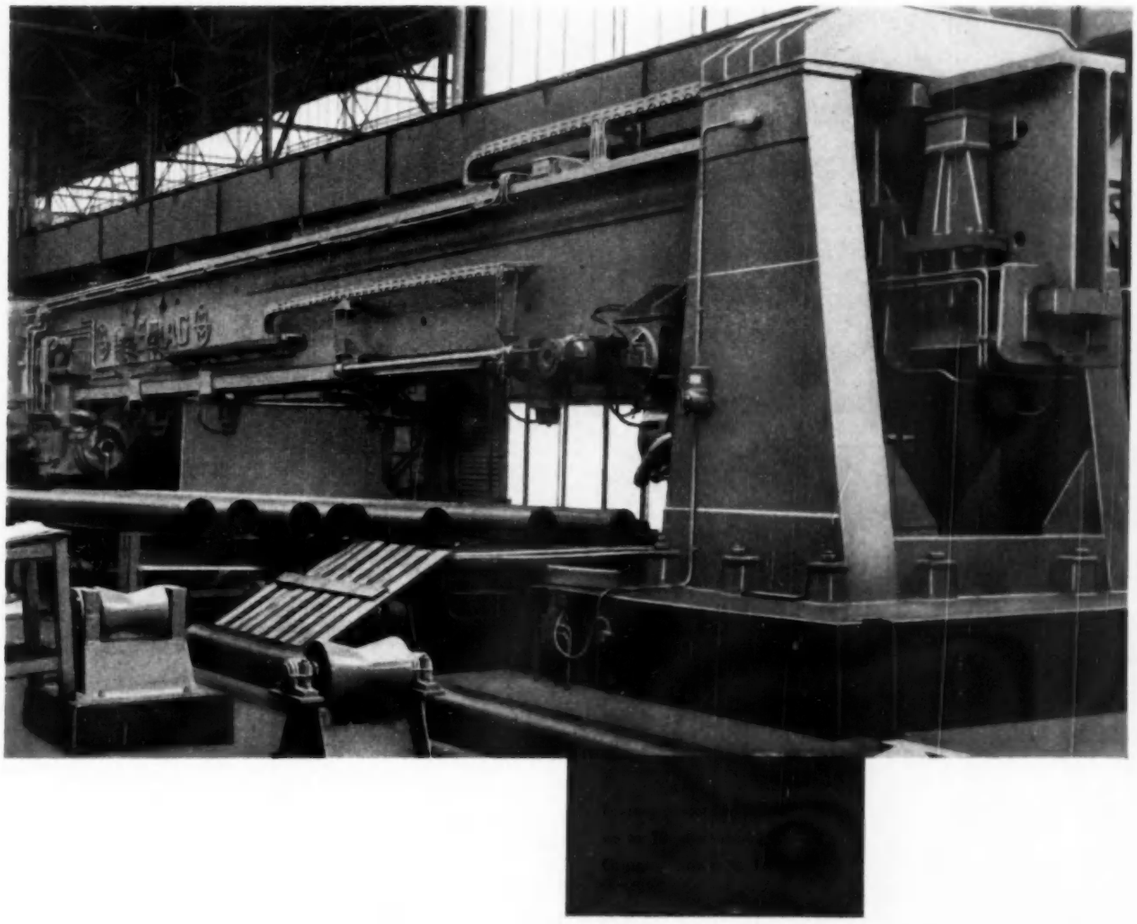

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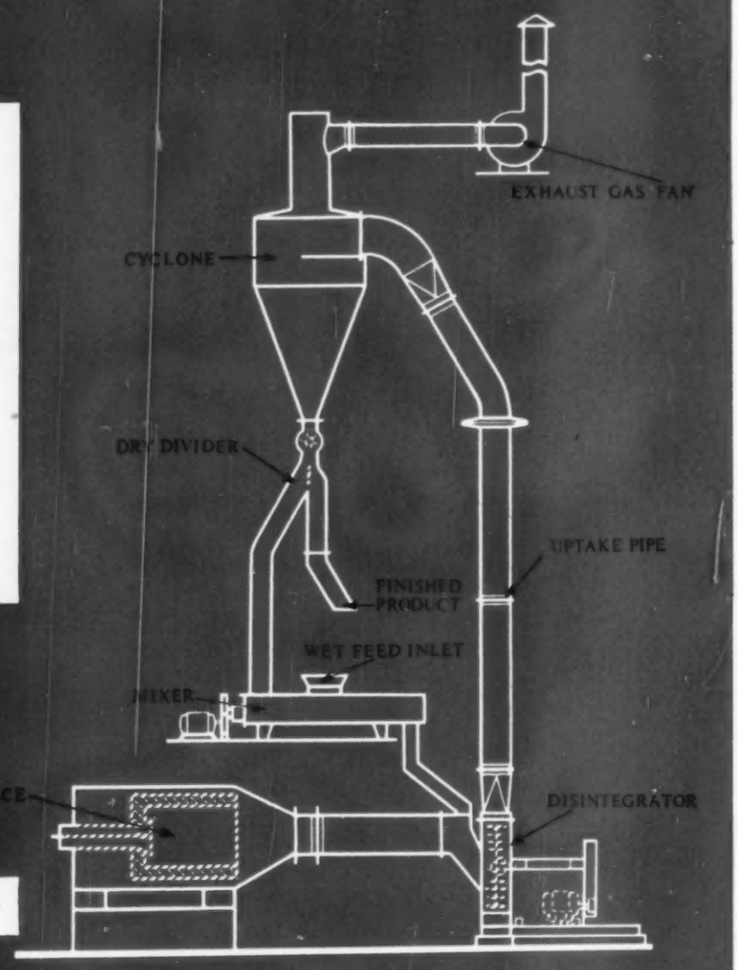

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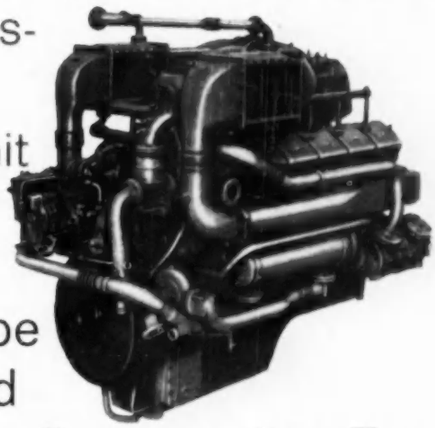

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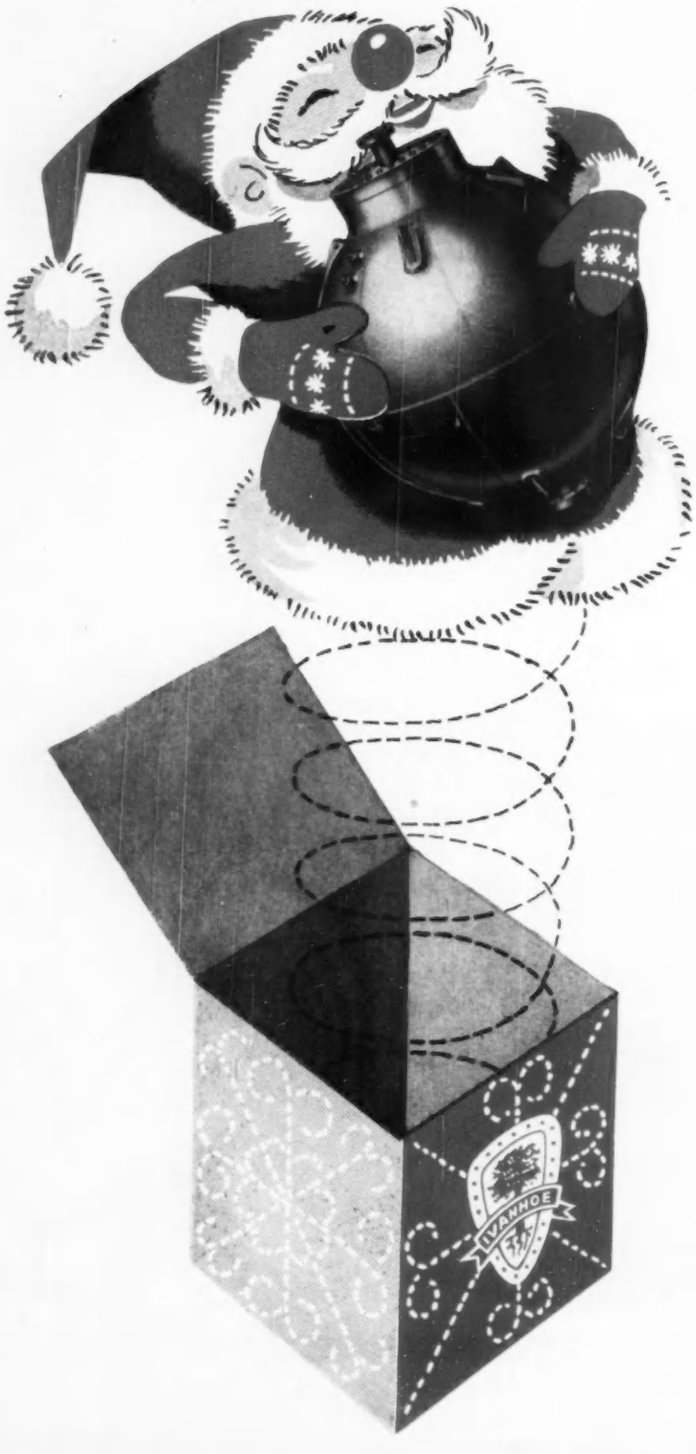

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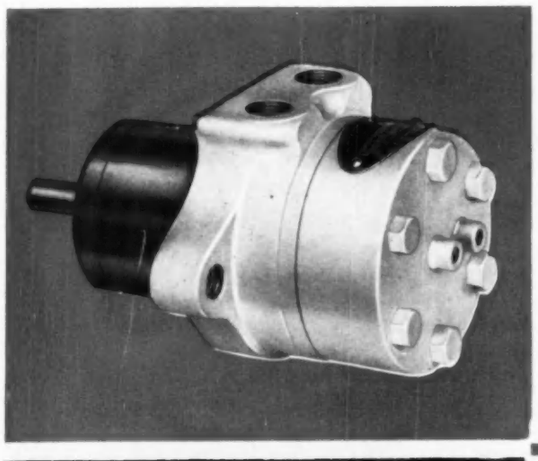

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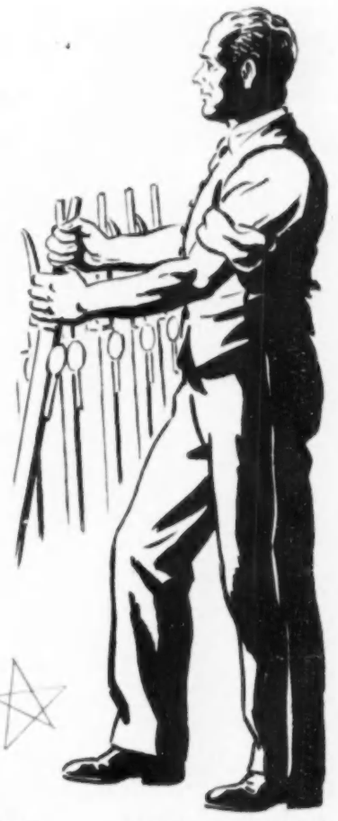

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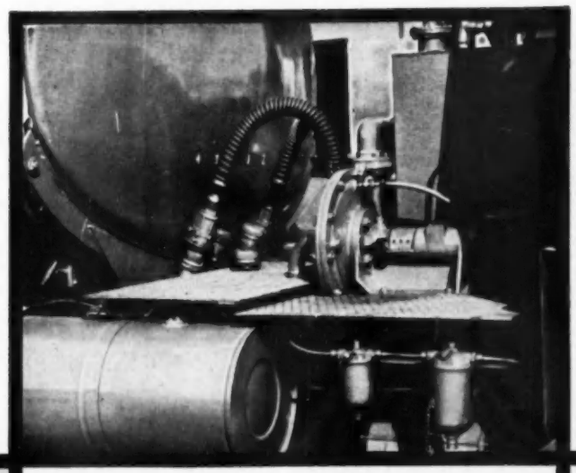

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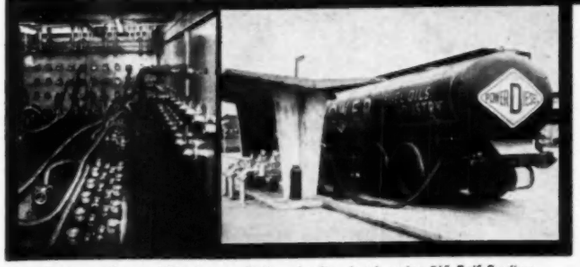

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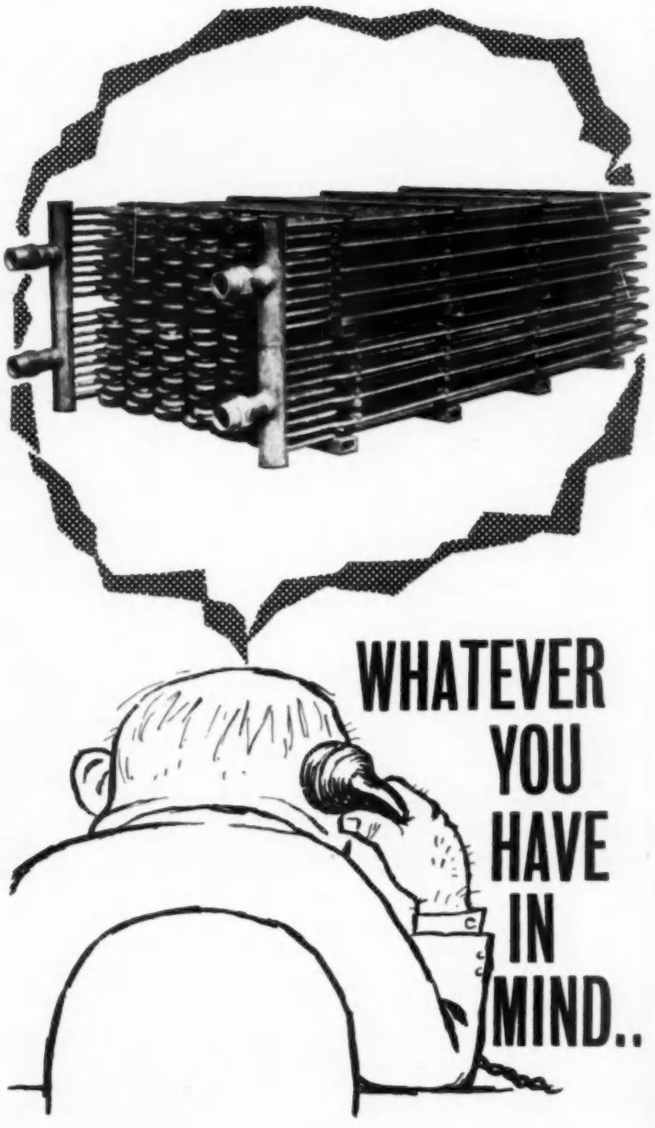

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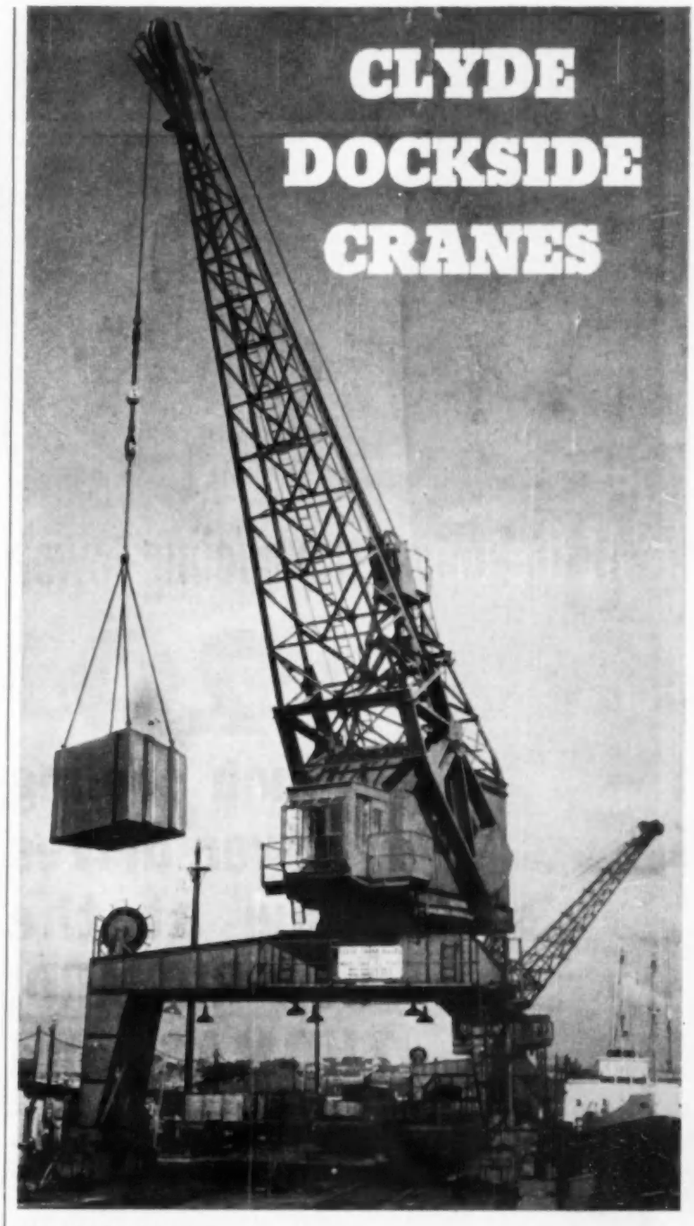

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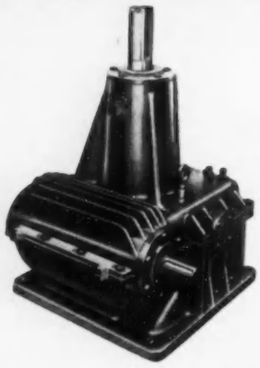

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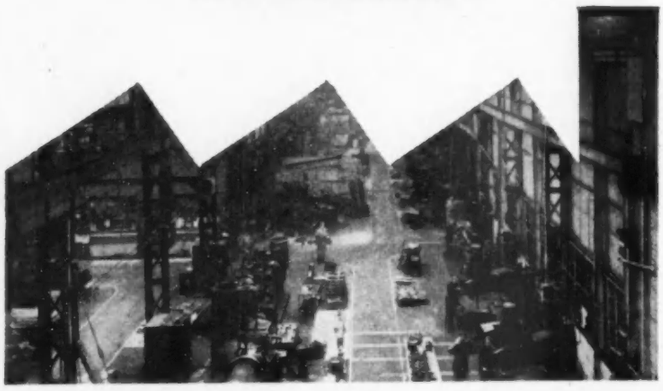

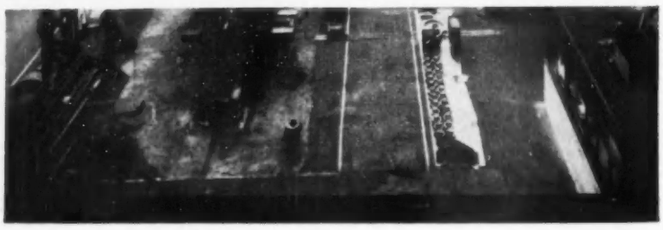

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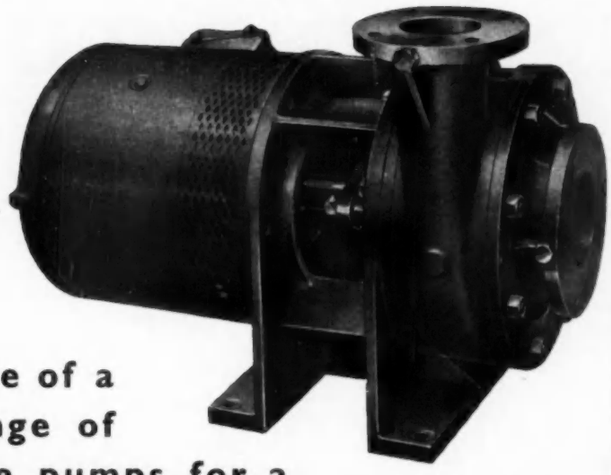

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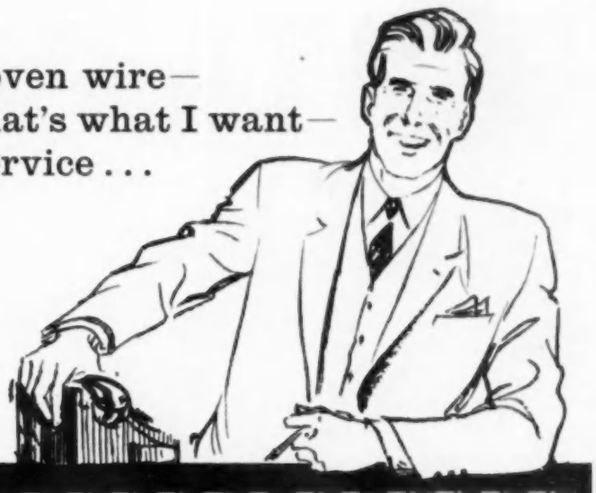

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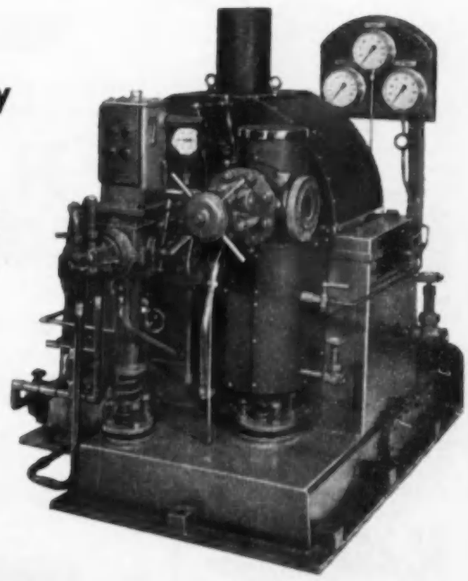

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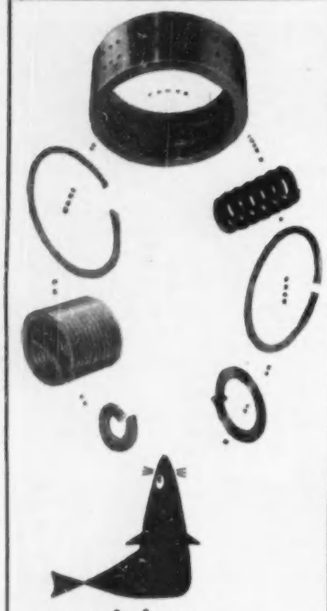

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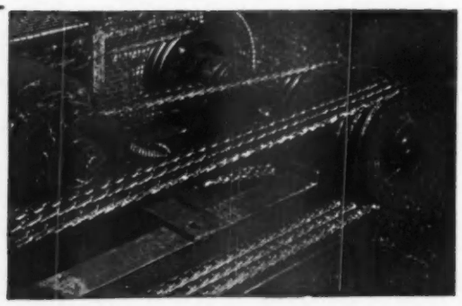

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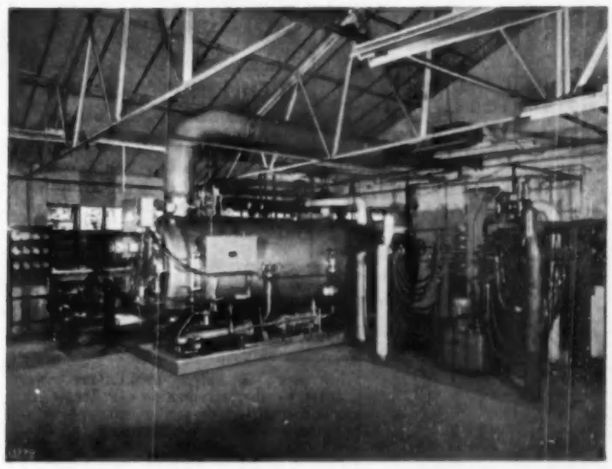

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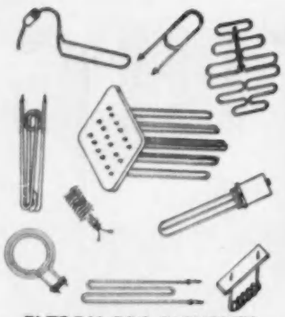

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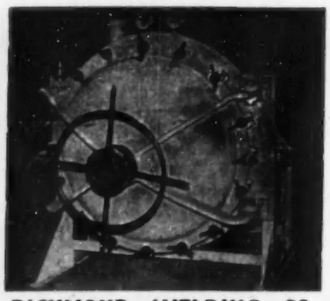

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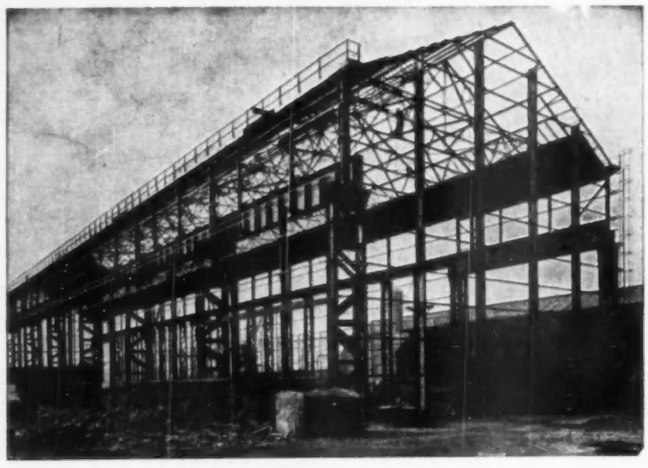

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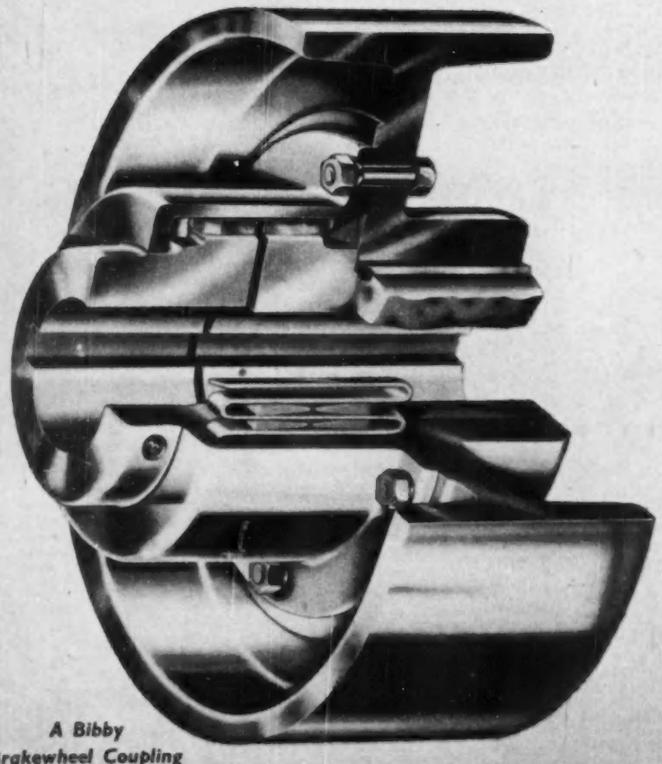

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* PYROBAR *is the AEI registered trademark for industrial heating elements made at Trafford Park and Rugby.*

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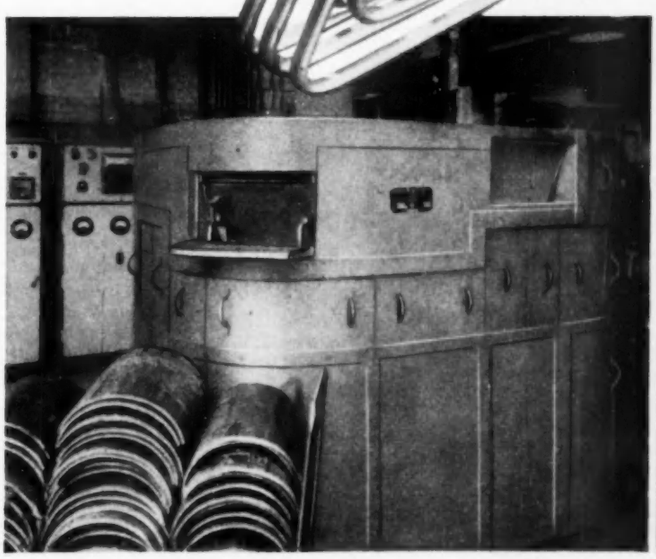

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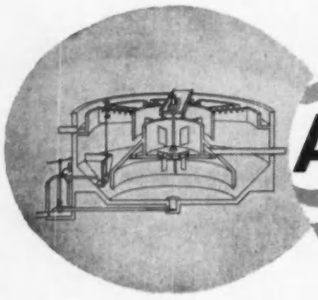

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THE ENGINEER

No. 5474 DECEMBER 23, 1960 Vol. 210

REPORT ON SHIPBUILDING AND MARINE ENGINEERING INDUSTRIES

With the publication of a report prepared by the Department of Scientific and Industrial Research and entitled "Research and Development Requirements of the Shipbuilding and Marine Engineering Industries" it becomes quite clear that, as we suspected, the supposed revelations of its contents made prematurely at the beginning of October related to an early "draft". It was a disservice to the shipbuilding industry to reveal the contents of that draft. The report acknowledges that world shipbuilding capacity is in excess of present and future demand and notes, among other matters, the present level of tonnage launched and of shipbuilding capacity; the slump in freight rates; the large amount of tonnage laid up; and the reduction in the tonnage on order. Another point made is that increase in cargo offering does not, due to the increase in ship speeds, result in a corresponding increase in tonnage. In reviewing the position of British shipbuilding, the report quotes the value of the net output at £200 million and comments that the industry's potential output of 1·75 million tons per year has never been attained since the war and that Britain's share of world tonnage launched is now about 16 per cent compared with 34 per cent pre-war, while other nations have practically doubled their outputs. Capital investment figures quoted demonstrate that modernisation programmes are presently accounting for over £18,000,000 per annum, or about 10 per cent of the net output, and due recognition is given to maintenance of full output during modernisation and to the brake put upon reorganisation by the climate of labour relations. The fall in Britain's tonnage for export and the rise in tonnage of British ships being built abroad is mentioned and the future requirements of British owners is assessed at about 1,000,000 tons per annum, leaving the balance of 400,000 tons, to maintain present production level, to be obtained as foreign orders.

On the subject of costs the report indicates the advantage enjoyed by British builders of being able to buy cheap steel and also remarks that British prices are higher than those ruling abroad, and that labour is considerably cheaper in Germany and Japan and dearer in Sweden. Higher productivity is adjudged the reason for Sweden gaining orders and this is borne out by the building times quoted. Swedish yards have twice the British rate of construction. The situation is attributed to labour conditions preventing the full use of the shipyard facilities in this country. An estimate is given of research expenditure but it is to be regretted that the additional amount quoted in a footnote should have been overlooked in the first instance and that the particular paragraph was not rewritten with the total and percentage adjusted to give a more current picture, instead of a misleading one. The report accords to shipbuilders willingness to adopt new developments and alertness to the possibilities of new techniques and attributes any tardiness in moving forward to a reluctance to cause labour upsets. Attention is drawn to the small scale production in the marine engineering industry and to the trend toward diesel propulsion where engines of much higher rating are now available. Points are made concerning the possible benefits of making available in the marine turbine field the knowledge, data and experience of manufacturers like A.E.I., Ltd., and English Electric, Ltd., and an impartial investigation is suggested. A technical and economic study is also recommended into the relative merits of various propulsion systems in order to formulate a co-ordinated policy for research and development.

Many of the facts established by this report on the world situation are already well known. With a world fleet of 116,000,000 tons and a world building capacity of 11,000,000 tons it is evident that all berths cannot be filled and that shipbuilding is now highly competitive. Furthermore the establishment of yards in countries formerly not engaged in shipbuilding has reduced the volume of tonnage offered for export. This position, coupled with the fact that countries such as Japan, Germany, Sweden and Holland already export about 60 per cent of their tonnage under construction compared with the British figure of 14 per cent, is indicative of the strength of their competitive position and of the need for British builders to achieve the same order of competitive efficiency. Although the potential of orders from British owners is estimated at 1·0 million tons per annum, leaving about 400,000 tons to be obtained from foreign owners to maintain the present level of production, it cannot be assumed that British owners will automatically place orders with British yards. At present British owners operate in a highly competitive market which is weighted against them by flags of convenience and discrimination and by State subsidies, so that the cost of a new ship must certainly not exceed that paid by a competitor. This dictum highlights one of the conclusions in the report. It refers to the need for research into management and production problems in shipyards. Planned production, efficient use of space and transport, maximum employment of machines, controlled lines of flow, are essential to increase productivity of labour and capital and reduce costs. These require the full co-operation of management and labour and a statesmanlike rather than sectarian approach to the problems involved. Another conclusion, that present research effort is insufficient in relation to current problems, does not appear to be wholly in accord with the expenditures of B.S.R.A. and Pametrada, while comments on marine engineering and its use of research facilities are in no way conclusive. The recommendations made in the report concerning the examination of research and development needs in shipbuilding and marine engineering should be of value provided that the D.S.I.R. and the Ministry of Transport

do work in close collaboration with the industry and its research associations. Any assistance given to reinforce the industry's own efforts to promote research into production techniques and methods will be welcome, while a greater welcome will be accorded to the proposal for development under contract. It is to be hoped that the report, when it has been digested and, in certain respects, implemented, will be to the eventual advantage of the industry in its efforts to be come more competitive and prosperous.

RESEARCH IN COAL-MINING

Visits to research establishments are always interesting not only from the technical angle but because they often give an impression of "things to come". For this reason we were in no way disappointed in the course of a recent visit to the Mining Research Establishment of the National Coal Board at Isleworth. Here we saw amongst many other developments two which might well be the beginning of the "manless working face" in coal-mines. These particular developments were a gamma-ray backscatter "coal sensing" device for steering coal cutting machines and a remotely controlled system of self-advancing roof supports. Naturally, the adverse and varying conditions in collieries and between coal seams themselves calls for a cautious approach and step-by-step investigation, but when these two developments are "married" an important advance will undoubtedly be achieved. A further technique of interest is the controlled "mole" coal cutting machine now under development. When, rather than if, the promise of these developments is fulfilled the number of men engaged in what is amongst the most unpleasant and dangerous forms of manual employment will be reduced to a minimum.

There is every evidence that the era of technological inquiry which was sparked off by the vast reconstruction plan for the coal-mining industry is rapidly gaining momentum and the early results are now coming into effect. As our notes on page 1057 indicate, the development projects in hand at M.R.E. cover a wide field and already many of the machines, instruments and techniques emanating from the research and development establishments of the N.C.B. have proved their effectiveness in field trials. With the wider acceptance and introduction of these developments into the mines of this country they will do much to increase productivity and safety at the coal-face.

Much of the research work now being carried out is of necessity long term, but in view of the state of the industry it would seem very desirable to accelerate promising development projects directed towards reducing the costs of winning coal. With this fact in mind it is evident that more money should be allocated to research and development, for we understand that only a fraction of 1 per cent of the N.C.B. annual revenue expenditure is devoted to this side of its activities. Possibly the answer is that, being "in the red" financially, the Board is trying to economise. But if so we would emphasise, as we have emphasised on other occasions, how false it is to economise on research expenditure. In difficult times it is much more likely to be true economy to expand research effort than to restrict it — indeed the wisdom of this course is fairly evident in this case for we understand that work carried out by the M.R.E. has already led to very considerable savings in materials and manpower.

BACK TO STEAM IN GLASGOW

Since the adoption of the 25kV single-phase a.c. system of electrification on British Railways, it has been rare to find traction engineers without some misgivings over its use in the conditions peculiar to this country. Even among those most opposed to the plan, however, there can be nothing but regret over the outcome of a series of faults in the transformers of multiple-unit trains for the recently-electrified Glasgow suburban lines. Withdrawal of the whole service on December 18, and its substitution by steam trains for a period as yet uncertain, is a blow to far more than the convenience of the Glasgow traveller. In conjunction with the electrical troubles in high-voltage a.c. trains running from Liverpool Street on which we commented last week, this latest setback, affecting fifty-eight train units, has the magnitude of a disaster. The apparent unpreparedness of all concerned for trouble on this scale is emphasised by the fact that as recently as last October engineers from many parts of the world were invited here to inspect and discuss this country's progress in a.c. traction at the British Railways Electrification Conference.

One reaction of engineers concerned in these events is that the commissioning of four major and scattered schemes between September and November has been like fighting on four fronts at once. They would have preferred to concentrate on one project, such as devoting all effort and expenditure to converting a reasonable length of main line between two important centres—Manchester to Birmingham for example. Policy dictated otherwise, however, possibly influenced by public pressure for improved suburban services. Such pressure is likely to arise in time in most parts of the world, and we have had the opportunity to show that the high-voltage a.c. system can meet these requirements as well as those of main lines. At this stage one can but hope that the opportunity has not yet been lost.

The Engineer—100 Years Ago (DECEMBER 21, 1860)

"Oxygen"

"This elementary substance is so universally met with in nature, and its uses are so numerous, that, were it possible to obtain it in large quantities, at a low rate, it would soon get into common use in various manufactories. In laboratories oxygen is obtained in various ways, and the cheapest has hitherto been that proposed by M. Boussingault, viz., the decomposition of the bi-oxide of barium. The compounds of barium, however, still fetch too high a price in the market to admit of their being employed as sources of oxygen on a large scale. MM. St. Claire-Deville and Debray having lately had occasion to make a series of experiments for the purpose of discovering a new method of treating platinum ore, have accidentally fallen upon a very cheap way of disengaging oxygen. This simply consists in exposing sulphate of zinc to a red heat, when it is decomposed into oxide of zinc, sulphurous acid, and oxygen.

Now sulphate of zinc is daily produced in large quantities by the electric pile, and, being but little used, may be had at a very low price; the oxide of zinc which results from its decomposition is now extensively used as a white pigment, and even sulphurous acid has its uses, so that the oxygen obtained would cost little or nothing."

The "Shay" Geared Steam Locomotive, 1879-1945

By R. A. S. ABBOTT*

Of the four distinct types of American geared steam locomotive, namely, the "Climax," "Shay," "Heisler" and "Baldwin," the most widely used system was undoubtedly the "Shay," manufactured in large numbers over a period of sixty-six years by the Lima Locomotive and Machine Works of Lima, Ohio. Regarded in Britain as an industrial machine of limited application, the "Shay" locomotive has never received due consideration in the technical press, and for this reason it is hoped that this historical review of a unique design will prove of interest to both the engineer and the historian.

Historical Introduction

THE highly successful "Shay" design of geared steam locomotive was originally due to the inventive genius of a professional logger, Ephraim Shay, who prior to the Civil War of 1861–1865 was logging near Cadillac, Michigan, and during the conflict served with the Corps of Engineers, returning after hostilities ceased to the Michigan woods. In 1860 Messrs. Carnes and Harper purchased the plant of Chapman–Donnelly and Co., situated in East Market Street, in the then small town of Lima, Ohio. This firm was first known as Carnes, Harper and Co., but within a year the name was changed to Carnes, Agerter and Co. and they immediately began to specialise in the manufacture of sawmills, general mill machinery and direct-acting circular saws. The business was reorganised as the Lima Machine Works in 1877.

In the meantime Shay had built a two-truck, gear-driven locomotive, powered with a donkey-engine and boiler, and perhaps due to previous business dealings he took his ideas on geared locomotives to Lima. The Lima Company immediately saw that the design possessed great merit and in August, 1879, its first locomotive was completed. This was for a gauge of 3ft and had a vertical boiler of 3ft 8in diameter set in between timber frames, but with the cylinders and running gear arranged substantially as to-day, driving all four wheels of each truck by horizontal shafts and bevel gears. The locomotive was of 10 tons weight, and except for the timber frames was very similar to that shown in Fig. 1, which illustrates one of the vertical boiler type built as late as 1885 (Works No. 131) for T. L. Hackney.

Other machinery manufactured by the Lima Machine Works soon gave way to locomotive construction, with the exception of logging cars which continued to be built for many years. The design of the "Shay" was rapidly improved, and after September, 1882, the wooden main frames were superseded by frames of rolled steel joists with truss rods and posts. By 1883 a horizontal boiler with a vertical firebox was being built and this particular design is illustrated here in Fig. 2, which is based on the drawing accompanying Shay's United States Patent No. 242,992, dated June 14, 1881. From this drawing it will be noticed that the two-cylinder engine was intended to be placed with the crankshaft at right-angles to the horizontal shafts and driving them through three bevel gears; whether this variation was actually tried in practice is not known.

Shortly after the appearance of the above design, the standard locomotive type boiler was adopted. Three cylinders were first used in 1884; the three-truck locomotive was first built in 1885, and the three-cylinder, three-truck combination together in 1890. It may be of interest to record here that the prototype of this latter design, a 91 ton locomotive built for the Montana Union Railroad, proved so successful that the attention of the Franklin Institute of Philadelphia was directed to the study of the "Shay" geared locomotive and a sub-committee on Science and Arts made a report dated December 31, 1891. As a result the John Scott Legacy Premium and Medal was awarded to Ephraim Shay by the Franklin Institute.

In 1892 a stock company was formed and the firm was renamed the Lima Locomotive and Machine Company, and their 450th locomotive was exhibited at the Chicago World's Fair in 1893. The three-cylinder, four-truck design appeared shortly after 1900. By the early years of the present century, therefore, a very comprehensive range of standard designs were in production, suitable for use not only on logging railroads, but also for industrial plants and for banking duties on main line railways. Due to the increasing demand for these locomotives, the building capacity of the old East Market Street Works was found to be inadequate and in 1901 the plant moved to a new 15-acre site on the south side of the town. By 1911 the capacity of these works was one locomotive per day, and an order for a locomotive could usually be completed within sixty days.

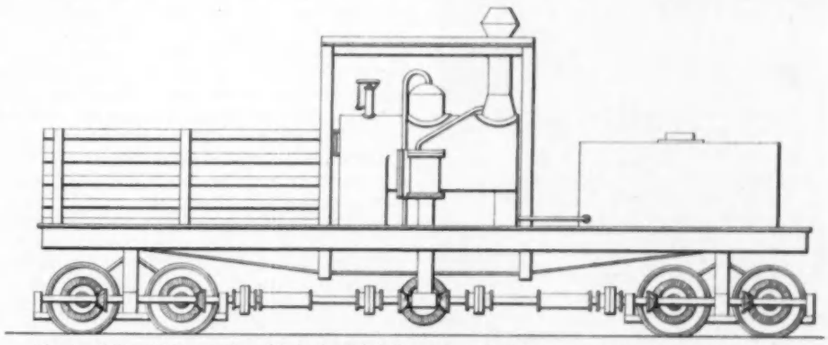

Fig. 2—"Shay" locomotive with horizontal boiler and vertical firebox as built about 1883 at Lima

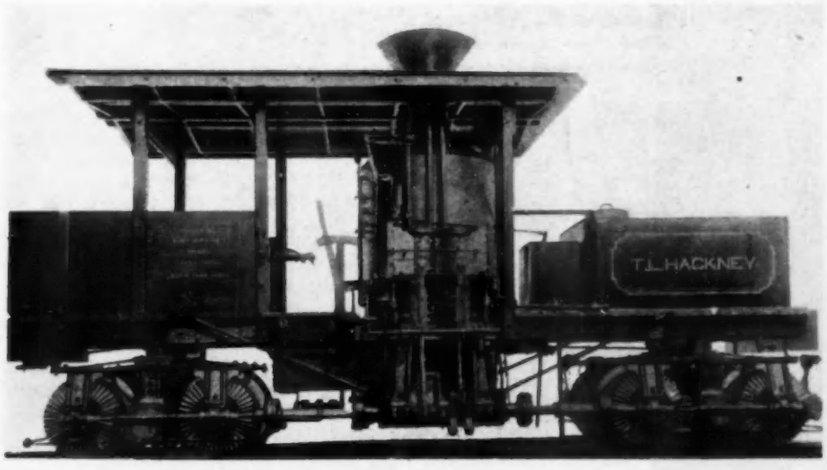

Fig. 1—Vertical boiler "Shay" locomotive built at Lima in 1885 for T. L. Hackney

General Description

The entire superstructure of the "Shay" locomotive was attached to a main frame, of which there were two types of construction—rolled steel joist and girder. On the class "60–2," "70–2" and "90–2" locomotives, the girder frame was standard; it could be used on any of the other sizes if desired by the customer. Girder frames were built of rolled steel plates and shapes securely riveted together, and provided a form of construction that would meet the most severe service conditions and withstand rough usage without damage. Oak bumpers were standard for both types of frames unless otherwise specified; cast steel bumpers could be furnished for either girder frames or the rolled steel joist type at additional cost.

All trucks were of the four-wheeled type with spring supported bolster and the

* Member, Newcomen Society.

locomotive structure was carried on the truck centre plates and side bearings. This construction provided the same freedom of movement as a car truck; the "Shay" locomotive could readily adjust itself to irregularities in the track and was less liable to derailment than a "rod" locomotive of equivalent power because of its relatively low centre of gravity.

This low centre of gravity was due to the general design which permitted ample

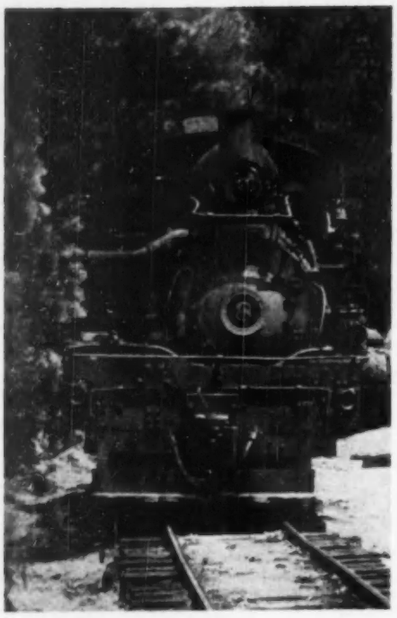

Fig. 3—Front view of 3ft 0in gauge "Shay" locomotive, showing off-set position of boiler

depth of throat without the necessity of raising the boiler over the frames. The truck side frames were of two types—arch bar and cast steel. On the class "60–2," "70–2" and "90–2" locomotives the cast steel side frame construction was standard, but this type of truck could be supplied to any of the smaller classes if desired.

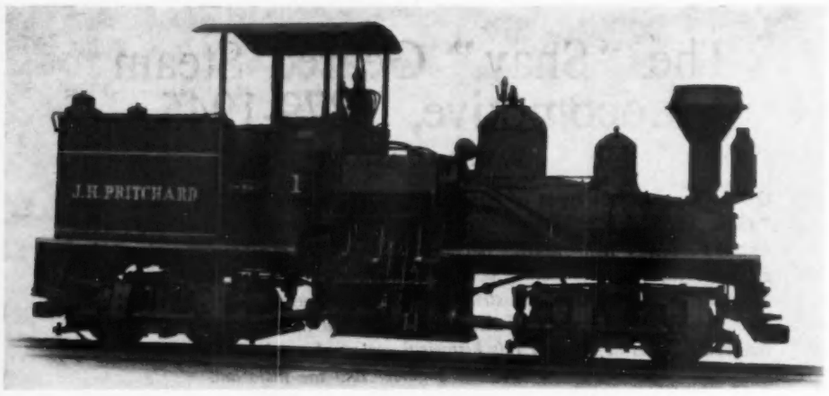

Fig. 5—Small 3ft 0in gauge wood-burning locomotive of class "10-2," built at Lima in 1920 for J. A. Pritchard. Note the three-cylinder engine; earlier small size "Shays" usually had two cylinders

The boiler was set over to the left of the centre line of the locomotive in order to balance the weight of the vertical engine fixed on the opposite side, and this constructional feature is well portrayed in Fig. 3, which is a recent photograph of a 3ft gauge locomotive operated by the West Side Lumber Company, Tuolumne, California.

The steam bracket was fitted on the right-hand side of the boiler and held by a large number of studs, the barrel being reinforced at this point by a large internal plate. The engine cylinders were secured to this bracket, but with the introduction of an improved design with piston valves in 1927, the engine was fixed to the frame and not to the boiler barrel.

The cylinders and cylinder frames (except in the largest sizes) were cast in one piece, and were machined throughout in one operation to ensure accurate alignment. At their lower ends all the cylinder frames were bolted to the bottom bracket containing the crankshaft bearings, and here again all the seats for bearings were machined in one operation. The standard valve gear was the Stephenson link motion.

The close-up view in Fig. 4 shows the arrangement of cylinders and valve gear on locomotive No. 91 owned by Rayonier Incorporated. The crankshaft of this engine is connected through universal joints to pinion shafts carried on each truck at the level of the centres of the wheels and outside them. These shafts, supported in large bronze bearings, carry the bevel pinions which engage with the bevel wheels fastened to each axle. These shaft bearings are in cast boxes of such a design that the depth of tooth engagement can be adjusted for wear. The bevel wheels are secured both to the axles and to the periphery of the wheels themselves.

The driving stresses on "Shay" locomotives were taken from the trucks to the superstructure through the weight-bearing pivots. In the three- and four-truck classes, a pseudo-tender or even a tender was added. The front of the tender rested with its centre on the locomotive main frame, and the one or two trucks on which it was carried, as the case might be, were driven in the same way as those of the locomotive proper; universal joints being provided at each end of each section of the transmission shaft. The universal joints were always used in pairs to correct any variation in velocity due to one of them, and the driving shafts had slip joints consisting of a cast steel square section and sleeve.

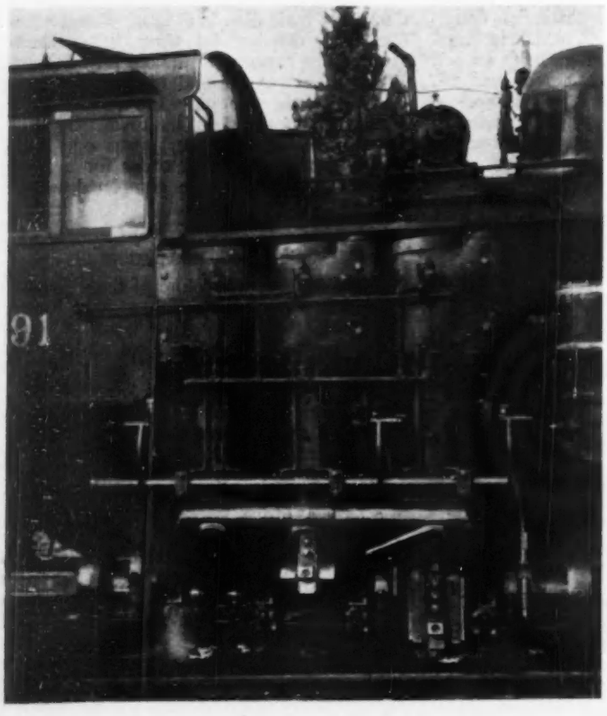

Fig. 4—Close-up view of "Shay" engine showing arrangement of cylinders and valve gear

The ratio of gear reduction varied from 2 : 1 to 3 : 1 and so with a three-cylinder engine whose cranks were set at 120 deg., there were from twelve to eighteen impulses per revolution of the road wheels, giving a very steady pull at the drawbar, and wheel spin was practically unknown.

To illustrate this point it will be convenient to mention here a series of acceleration tests undertaken in the works' yard at Lima sometime prior to 1921, over a 700ft length of track. The locomotives were run for 200ft and stopped, then started and run 200ft futher, reversed and run back 300ft.

The elapsed time was noted for all these operations, the average of a number of runs being taken as the final figure. In all cases the load hauled was the same, although the actual weight of the test trains is not known. The results of these tests showed that a "Shay" locomotive would accelerate from a standing start up to 100ft in 11½ seconds; to 200 in eighteen seconds; to 300ft in 23½ seconds; to 400ft in 28½ seconds and to 500ft in 32¾ seconds. It should be understood however that the running speeds of

TABLE I—*Principal Dimensions of "Shay" Geared Locomotives*

Class	Cylinders			Wheelbase		Wheels		Boiler pressure, lb per sq. in	Capacity of water tanks, gallons	Fuel capacity coal, tons	Fuel capacity wood, cords	Fuel capacity oil, gallons	Weight in working order, lb	Tractive effort, lb	Extreme height of locomotive	Extreme width of locomotive	Minimum gauge practicable, in	Sharpest radius curve advised, ft	Lightest rail advised, lb per yard
	Number	Diameter, in	Stroke, in	Truck, in	Total	Number	Diameter, in												
					ft. in.										ft. in.				
"10-2"	2	5	8	36	15 4	8	20	150	300	¼	¼	—	—	3,460	9 0½	—	18	35	10
"10-2"	3	4½	8	36	16 0	8	22	160	400	¼	¼	125	27,000	4,600	9 3	5 3	24	30	12
"13-2"	2	6	10	48	18 10	8	22	160	400	¼	¼	125	28,200	6,050	9 5	8 3	24	50	12
"18-2"	2	7	12	50	21 2	8	29	160	730	1	¼	285	41,300	7,480	10 10½	8 5½	24	50	16
"20-2"	2	8	12	50	23 2	8	26	160	830	1	¼	—	—	10,270	10 10½	—	24	50	20
"20-2"	3	6	12	50	23 10	8	29	160	730	1	⅛	285	51,000	8,600	11 3	8 6	24	50	20
"24-2"	3	8	8	50	24 1	8	29	160	830	1½	1	500	55,300	9,750	11 5	8 2	24	75	20
"28-2"	3	8	10	50	24 5	8	29	160	850	1½	1¼	500	59,300	12,200	11 5	8 5	30	75	25
"32-2"	3	8	12	50	25 5	8	29	160	1,000	1½	1½	500	62,500	13,500	11 6	8 8	30	75	25
"36-2"	3	10	10	50	26 5	8	29	180	1,200	1½	1½	800	78,000	14,320	12 4	8 9½	30	75	30
"42-2"	3	10	12	50	27 2	8	29½	180	1,560	2	1½	800	87,000	16,900	13 0	9 6	30	75	35
"50-2"	3	11	12	52	28 10	8	32	200	1,750	3½	2	950	105,200	22,580	13 4	9 6	36	75	45
"60-2"	3	12	12	56	33 1	8	36	200	2,500	3½	2	1,200	140,000	24,000	14 1	10 0	42	75	55
"70-2"	3	13	15	60	34 10	8	40	200	3,000	5	2½	1,500	169,000	32,480	13 7½	10 5	56½	75	60
"90-2"	3	15	17	68	39 0	8	43	200	3,500	5	2½	1,500	186,000	41,030	14 0	10 8	56½	150	80
"70-3"	3	12	15	52	40 2	12	34	200	2,300	5	3	1,200	174,700	36,150	14 2	—	36	100	45
"80-3"	3	13¾	15	56	44 8½	12	36	200	3,500	5	—	1,200	204,600	36,100	12 10½	—	56½	100	60
"90-3"	3	14½	15	56	45 6	12	36	200	3,500	5	—	1,500	209,800	40,400	13 10½	—	56½	100	60
"100-3"	3	15	17	58	45 6	12	40	200	4,000	6	—	—	—	44,100	13 10½	—	56½	100	65
"125-3"	3	17	18	64	46 10	12	46	200	4,000	9	—	—	—	53,000	14 4	—	56½	100	70
"150-3"	3	17	18	68	49 0	12	40	200	6,000	9	—	—	308,000	59,700	14 11	—	56½	—	—
"150-4"	3	17	18	61½	58 4	16	46	200	8,000	9	—	—	297,500	53,000	14 4	—	56½	125	70

all "Shay" locomotives were necessarily low, varying from 4 to 7½ m.p.h. on gradients, to 9½ to 19 m.p.h. on the level.

The boilers were of the standard locomotive pattern with ample steam space insured by the "extended wagon-top" design used on all but the smallest class. These boilers had a reputation for being exceptionally good "steamers" with low fuel consumption due to the rapid but steady draught induced by the exhaust from three cylinders.

All classes could be equipped with the "Elesco" fire-tube type of superheater, and provision made to burn hard or soft coal, coke, wood of all varieties, and oil; the firebox, grate, dampers, front-end layout and stack being changed to suit the fuel desired.

In Table I the leading dimensions and other details are set out covering twenty-two sizes of "Shay" locomotive.

The figures in the table represent standard construction; most dimensions could, however, be varied to suit special conditions and for this reason it is only considered necessary to record the boiler dimensions of seven classes, taking as examples the locomotives illustrated in Figs. 5 to 12. These illustrations also cover the complete range of truck, frame and engine combinations.

The small 3ft gauge wood-burning locomotive of class "10-2" illustrated in Fig. 5 was built in 1920 for J. A. Pritchard, and is of particular interest in that it had a three-cylinder engine; earlier small size "Shays" usually had two cylinders. The truck frames were of the arch-bar type and the main frame of rolled steel joist construction. The boiler diameter was 18½in, and the firebox had a length of 36in and a width of 19½in, giving a heating surface of 25·5 square feet. There were twenty-three tubes of 1¾in diameter and 5ft 11½in long, and these provided 62·1 square feet of heating surface, making a total of 87·6 square feet. The grate area was 4·87 square feet.

In 1915 a wood-burning locomotive of class "18-2" was supplied to the Wawa Commercial Company, Fig. 6, and here the truck frames were of the arch-bar form and the main frames of rolled steel joists, but the engine was of the two-cylinder pattern. The boiler diameter in this instance was 31½in, and the firebox measured 36in long by 25⅞in wide, providing 34 square feet of heating surface. The forty-four tubes had a diameter of 2in and were 9ft long, giving a heating surface of 204 square feet, the total heating surface being 238 square feet with a grate area of 6·46 square feet.

A class "28-2" locomotive is illustrated in Fig. 7 and it was built in 1921 for the metre gauge Leopoldina Railway in Brazil. This locomotive had arch-bar truck frames, and main frames of rolled steel joists. The non-driving side is shown in Fig. 8. In this instance the boiler was 35⅜in in diameter, and the firebox 50in long by 35⅜in wide with a heating surface of 61 square feet. The seventy-five tubes of 2in diameter were 8ft 11½in long, giving a heating surface of 348 square feet, the total heating surface being 409 square feet. The grate area was 12·28 square feet.

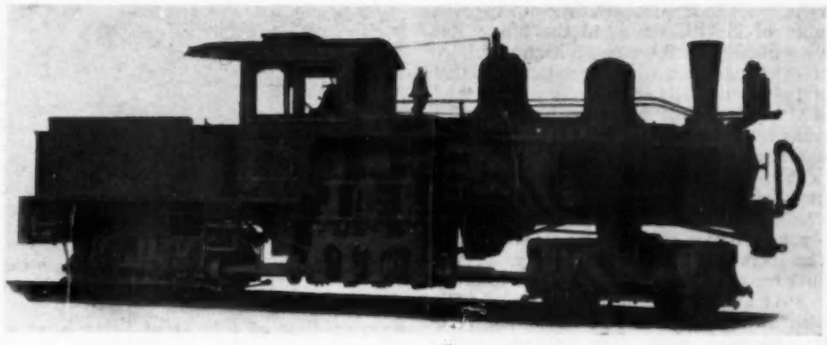

Fig. 7—Metre-gauge locomotive of class "28-2" built at Lima in 1921 for the Leopoldina Railway, Brazil

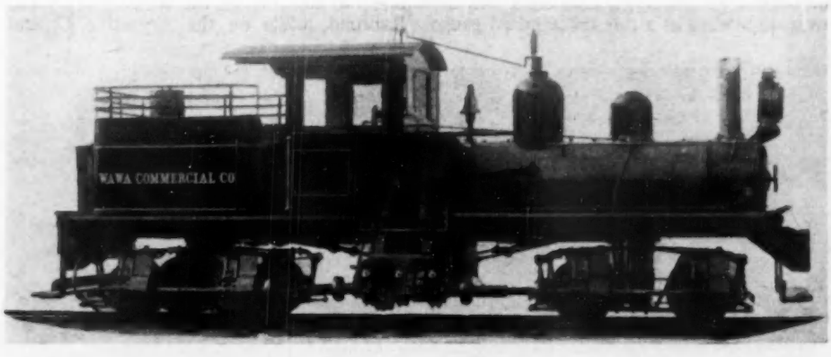

Fig. 6—Two-cylinder wood-burning locomotive of class "18-2" supplied to the Wawa Commercial Company in 1915 by the Lima Locomotive and Machine works

Locomotives of class "60-2" had a boiler diameter of 46½in, and a firebox 72½in long by 42in wide. There were 210 tubes of 2in diameter, 10ft 11⅜in long. The tube heating surface amounted to 882 square feet and that of the firebox, 109 square feet, making a total of 991 square feet, and the grate area was 21·14 square feet. An oil-burning locomotive of this class is illustrated in Fig. 9 and this was built in 1921 for the Eufaula Lumber Company.

The locomotive shown in Fig. 10 is an example of class "70-3" built in 1920 for the Finkbine Lumber Company. The firebox length was 72½in with a width of 44½in giving a heating surface of 113 square feet. The boiler diameter was 50in and contained 190 tubes of 2in diameter with a length of 10ft 11⅛in. With a tube heating surface of 1080 square feet the total heating surface

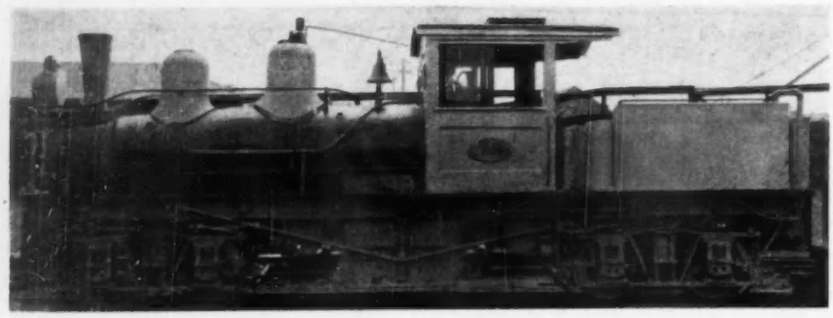

Fig. 8—View of the non-driving side of metre-gauge locomotive of class "28-2," built at Lima for the Leopoldina Railway, Brazil, in 1921

came to 1193 square feet. The grate area was 22·53 square feet. This locomotive was adapted to burn either coal or wood. When superheated this class had ninety-seven tubes of 2in diameter and fifteen flue tubes of 5¾in diameter. The heating surface was then made up as follows: tubes and flues 783 square feet, firebox 105 square feet, total 888 square feet. Superheater 189 square feet.

A more modern oil-burning superheated "Shay" of class "80–3" is illustrated in Fig. 13. This three-truck locomotive was built in 1928 for the Cascade Timber Company, and had the latest type of piston valve engine introduced in 1927. The truck frames were of cast steel and the main frame of the deep girder type. The boiler diameter was 50⅛in, and the firebox length and depth was 89¼in by 44½in respectively. The ninety-seven tubes of 2in diameter and the fifteen flue tubes of 5⅜in diameter gave a heating surface of 783 square feet which, together with that of 122 provided by the firebox, made a total of 905 square feet. The superheater heating surface was 189 square feet. The grate area was large amounting to 27·75 square feet.

The final class to be illustrated is the four-truck type of which only a small number were built, and it was considered to be an obsolete design by the nineteen-twenties. The locomotive illustrated in Fig. 12 was built for the Chesapeake and Ohio Railroad in 1911 and had a boiler diameter of 62⅞in with a very large firebox measuring 114in long by 61¼in wide. The 310 tubes had a length of 13ft 6in and a diameter of 2in. The heating surface was made up of 2178 square feet in the tubes and 155 square feet in the firebox, making a total of 2333 square feet. The grate area was very large, being 48·48 square feet.

This locomotive was a coal-burner and was employed on the 1 in 22 grades of the Loop Creek branch. Another railroad to make use of this four-truck type was the Norfolk and Western where it was used on pusher service on Elkhorn Mountain in Western Virginia.

Production

In the sixty-six years between 1879 and 1945 the output of "Shay" geared locomotives from the Lima works reached the remarkable total of 2762, and the following statement showing numbers built gives an idea of the growth and decline of the demand.

Year	Number built in year	Number in decade
1879	1	
1890	64	303
1900	38	301
1910	147	1239*
1920	96	725
1930	3	189

* Including a record number of 217 in 1907.

After 1930 only five "Shays" were ordered, in fact, during some years none were built. The last one, produced in 1945, was more or less a command order which the Lima Company conceded to build to oblige a particular customer—the Western Maryland Railroad. This was the most powerful "Shay" built and had three cylinders 17in diameter by 18in stroke; wheels 4ft diameter; a working pressure of 225 lb per square inch and a tractive effort of 59,740 lb. The total weight in working order was 162 tons. This locomotive, No. 6, was used, along with some older "Shays," in the Western Maryland coal-mining district, and its duties entailed the pushing of 200-ton coal trains up a gradient of 1 in 11 at 5 m.p.h. at a colliery near Chaffee, West Virginia. This fine locomotive had a very short working life due to the closing down of the colliery, and it is now preserved in the Baltimore and Ohio Museum.

It was customary for all sizes of locomotives, up to and including class "36–2," to be shipped on flat cars, set up ready for fuel, water and firing up for service. Locomotives larger than class "36–2," when built for the standard gauge track, were sent away on their own wheels. Locomotives of narrow or unusual gauges, larger than class "42–2" were dispatched as a rule on standard gauge trucks, and the narrow gauge trucks loaded on a flat car accompanying the locomotive. All small parts liable to injury or theft were usually removed and packed inside the cab which was enclosed and loaded on a separate car.

Distribution

Although used so extensively on the logging railroads and in the industrial plants of North America, the great flexibility and good adhesion qualities of the type were early recognised by the mechanical engineers of many main line railways both in North and South America and overseas, and the "Shay" locomotive soon achieved a world-wide distribution.

It was used for both passenger and goods service, and for banking purposes in Canada; Mexico; Guatemala; Cuba; Equador; Chile; Brazil; Honolulu; Christmas Island; Australia; Tasmania; Philippine Islands; Formosa; China and Japan. It is perhaps not generally known that a "Shay" locomotive has worked on an industrial railway in England. About 1900 the firm of Alfred Hickman of the Staffordshire Steel and Ingot Ironworks, Bilston (now the Bilston Iron and Steel Works of Messrs. Stewarts and Lloyds, Ltd.) purchased a two-truck locomotive to suit the standard gauge line in and around the plant. According to the maker's records this locomotive had wheels 2ft 2in diameter; three cylinders 8in diameter by 12ft stroke; a tractive effort of 9960 lb and a weight of approximately 25 tons. It was taken out of service before 1930.

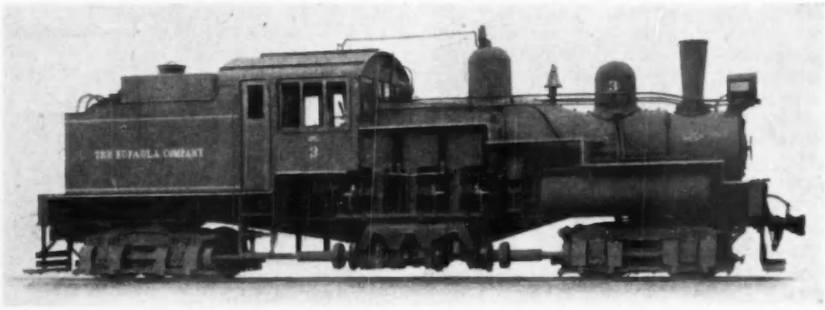

Fig. 9—An oil-burning locomotive of class "60-2," built for the Eufaula Lumber Company in 1921 by the Lima Locomotive and Machine Works

Performance

The performance of a "Shay" locomotive approached very near to that of a rack-rail locomotive in the steepness of the gradients up which it could haul a payload. As already mentioned above, a gradient as steep as 1 in 11 was successfully worked with loads of up to 200 tons on the Western Maryland Railroad, while on the Argentine Central

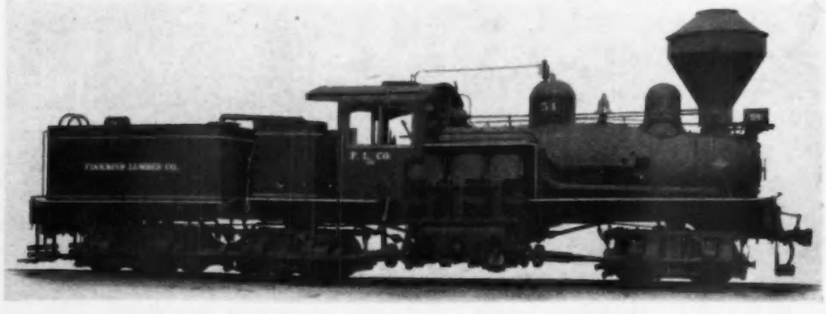

Fig. 10—Locomotive of class "70-3" built at Lima in 1920 for the Finkbine Lumber Company

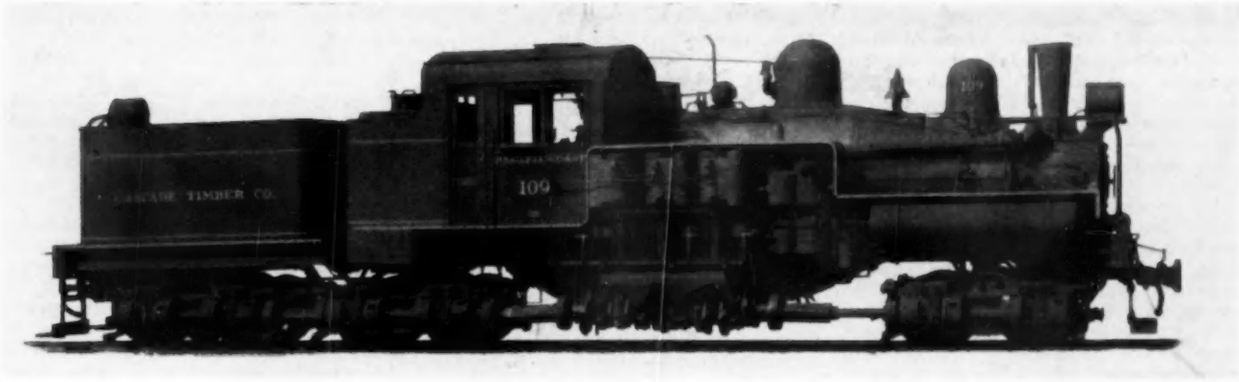

Fig. 11—Superheated oil-burning locomotive of class "80-3," built for the Cascade Lumber Company in 1928. The three-cylinder engine had piston valves, as introduced by the Lima Locomotive and Machine Works in 1927

Railroad (U.S.A.) passenger trains of three coaches weighing 24 tons 12 cwt empty were taken up gradients ranging from 1 in 16·6 to 1 in 12·5 to the summit of Mount McClellan in Colorado (altitude 14,007ft) by two-truck locomotives weighing 44 tons 5 cwt.

The metre gauge Arica–La Paz Railway in Bolivia employed two-truck locomotives to work passenger trains weighing 57 tons up gradients of 1 in 16·6. On the Mount Tamalpais Mountain Railway, near San Francisco two-truck locomotives climbed to a height of 2508ft in 8·2 miles with 281 sharp curves and a maximum gradient of 1 in 14·28. As a final example, on the metre gauge Transandine Railway in Chile, three-truck locomotives weighing 59 tons and with a gear ratio of 2·21 to 1 were used to haul trains of 80 tons up gradients as steep as 1 in 12·5.

Later Days at Lima

In addition to the large numbers of "Shay" type geared locomotives built prior to 1912, the output at Lima had also included a range of small "rod" locomotives of moderate dimensions, suitable for industrial service. In 1912, however, an order was secured from the Erie Railroad for five large locomotives and from then on the Lima Locomotive and Machine Works supplied locomotives to many main line railroads.

At the close of World War II nearly all the American railroads embarked on large-scale programmes for using diesel locomotives, and shortly afterwards the Lima works, in common with most other builders, found that there was no longer a market for steam locomotives. A merger was effected in 1947 with the General Machinery Corporation of Hamilton, Ohio, manufacturers of diesel oil engines, and the new firm known, as the Lima-Hamilton Corporation, entered the rapidly expanding diesel locomotive field. The last new steam locomotive was a 2–8–4 for the Nickel Plate Railroad (Road No. 779) in 1949. In 1950 the Westinghouse Electric Company purchased the controlling interest of both the Baldwin Locomotive Works and the Lima-Hamilton Corporation as an outlet for its traction equipment, combining these two firms as the Baldwin-Lima-Hamilton Corporation and concentrating all locomotive building at the former Baldwin plant at Eddystone. The distinction of being the last steam locomotive to leave the Lima erection hall belongs to a small 0–4–0 fireless switcher originally built in 1910. The owners, the National Cash Register Company of Dayton, had returned it for repairs in October, 1950. Locomotive building at Lima came to an end on Wednesday, September 12, 1951, when a 2500 h.p. transfer diesel was completed for the Pennsylvania Railroad (Road No. 5683).

At the present time these famous works are occupied with the production of power shovels, cranes, and crushing machinery, a range of equipment originally started in 1928 as a sideline.

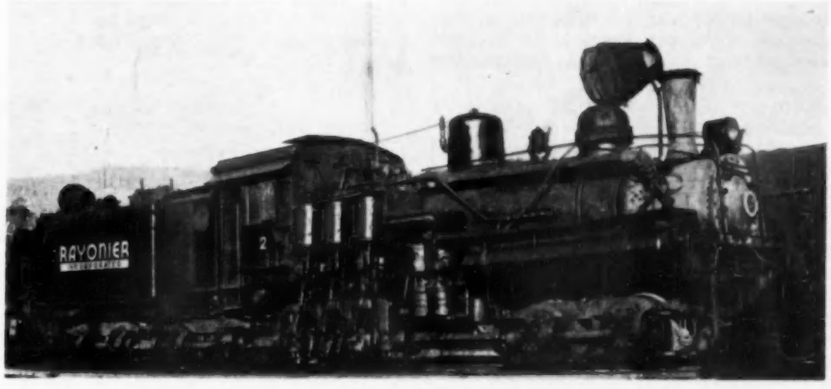

Fig. 13—The last "Shay" locomotive produced by the Willamette Iron and Steel Works, Portland, Oregon. This was built in 1929 for the J. Neils Lumber Company

The Willamette "Shay"

For various reasons, such as ease of delivery and facility for repairs, it was thought desirable to have an establishment for the building and repair of "Shay" locomotives on the Pacific coast. The firm appointed

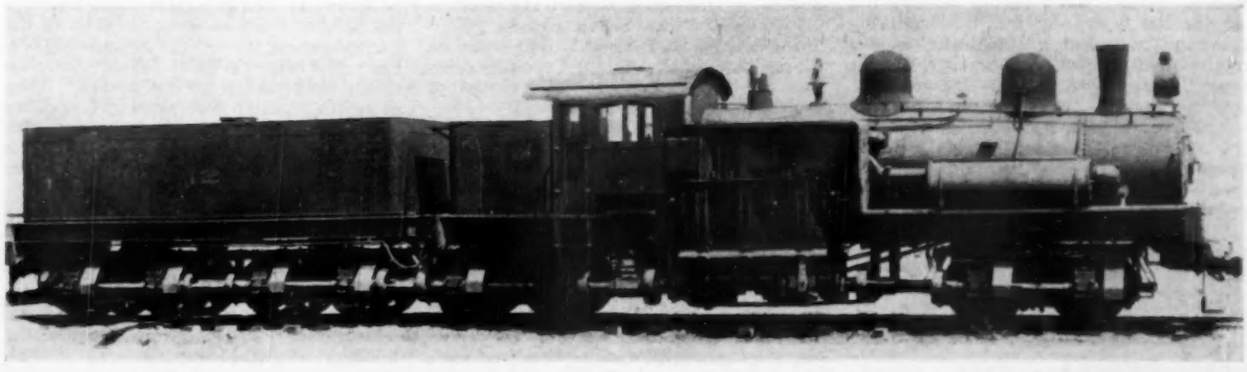

Fig. 12—Four-truck locomotive of class "150-4" built in 1911 by the Lima Locomotive and Machine Works for the Chesapeake and Ohio Railroad

by the Lima Company to undertake this work was the Willamette Iron and Steel Works, of Portland, Oregon, and its first locomotive was built in November, 1922, for the Coos Bay Lumber Company, Marshfield, Oregon. This was a three-truck design, with a three-cylinder engine developing 900 h.p. at a boiler pressure of 200 lb per square inch.

The principle visual difference between a Lima "Shay" and a Willamette "Shay" was in the construction of the three-cylinder engine. On the Lima engines the cylinders and valve chambers were placed in line parallel with the centre line of the boiler, while with a Willamette engine the valve chambers are in line with the cylinders, but outside at right angles to the centre line of the boiler. Also Walschaerts valve gear was used in place of the Stephenson link motion favoured by the Lima Company.

Whatever may have been the amount of repair work carried out, new construction did not reach a very high figure, and the last Willamette "Shay" was built in 1929 for the J. Neils Lumber Company. This locomotive, illustrated here in Fig. 13, carried the Works No. 34, and was of the three-truck type with three cylinders of 12½in bore by 15in stroke; wheels of 3ft diameter; a boiler pressure of 200 lbs. per square inch and a tractive effort of 39,320 lb. It was later acquired by Rayonier Incorporated for use on its Clallam operation and was withdrawn from service in 1956. Due however to its historic interest, this locomotive is to be preserved and it is now stored at the corporation's Hoko Camp.

"Shay" Models

In recent years the "Shay" locomotive has attracted the attention of those commercial model makers in Japan who build for the American market, and both two-truck and three-truck types are available on "HO" gauge. Constructed almost entirely of brass, the workmanship of these small electrically-driven locomotives is outstandingly good and the detail work is akin to that of fine watch and clock making. It is now possible to purchase these models in Britain through the concessionaires, Messrs. John Underhill, 32, Minster Street, Reading, but due to their hand-built construction, quantities are very limited.

Conclusion

In conclusion the author wishes to thank all those who have assisted in making this historical review as complete as possible, particularly J. F. Bruton, Esq., of Fulham, P. E. Percy, Esq., of Lima, Ohio, and C. E. Fisher, Esq., of Boston, Massachusetts. For the use of photographs acknowledgment is due to the following: Figs. 1 and 5 to 12 courtesy of the Baldwin-Lima-Hamilton Corporation; Figs. 3, 4 and 13 courtesy of S. Kistler, Esq., of Pasadena, California. The drawing, Fig. 2, is based on the one accompanying United States Patent Specification No. 242,992.

Dounreay Fast Reactor

(*Continued from page* 1016, *December* 16)

No. III—HEAT TRANSFER CIRCUITS

A symposium on the Dounreay Fast Reactor, arranged by the Institution of Mechanical Engineers, under the aegis of the British Nuclear Energy Conference was held in London on December 7. The second paper, by R. R. Matthews, W. G. Hutchinson,† P. K. Richards,‡ A. S. Fenemore,§ and M. H. Ewbank,‖ dealt with the design and construction of the Dounreay Fast Reactor heat-transfer circuits, steam generating plant and reactor-control system. Extracts from this paper are reproduced below.*

THE heat-transfer system is designed to remove 60MW(H) from the core and 12MW(H) from the breeder when using 70/30 per cent by weight sodium-potassium (NaK) alloy as coolant, and throughout the design emphasis was placed on the necessity to reduce to a minimum the risk of coolant loss or coolant flow failure. It was not the intention to optimise the heat-transfer system for efficient power production. The philosophy has been to provide a simple and reliable system, which would without fail remove the heat from the reactor during operation and during shut-down, at the outputs and temperatures required by the experimental programme.

When design commenced in 1953 considerable experience had been obtained on the operation of 1in and 4in NaK rigs at Windscale[1] and Harwell[2], and confidence had been established in the use of 18/8/1 titanium stabilised stainless steel components fabricated by the use of butt-welding techniques with radiography. A period of at least two years would have been required for the development and proving of large shell and tube-type heat-exchangers and large NaK pumps, so it was decided to base the design on the proven manufacturing and operating techniques obtained from the 4in rigs and not to extrapolate in size any more than necessary. The coolant circuits have therefore been constructed from tubes of which the largest is 6in diameter and the smallest ¾in diameter and the use of valves has been avoided. The primary-secondary heat-exchangers utilise a simple form of concentric tubular construction. Electromagnetic pumps of similar capacity to those already tested on the rigs were chosen, and these considerations led to the requirement of twenty-four primary circuits.

The primary coolant in passing through the core becomes radioactive. If, despite all the precautions taken, a leak occurred in the primary system then the NaK could ignite with the oxygen in the atmosphere, while at the same time the fission product gases from the core might be released to the atmosphere. It was therefore decided to contain the whole of the radioactive section of the plant in a steel sphere 135ft diameter. In order to specify the design conditions for the sphere, the most pessimistic assumption was made that the NaK could continue to burn until all the oxygen in the sphere was exhausted. This gave a pressure rise to 18 lb per square inch gauge and a temperature rise in the sphere atmosphere of 320 deg. Cent. followed on cooling by a vacuum of 10·7 lb per square inch absolute and the sphere was therefore built to withstand these conditions.[3]

Heat is removed from the primary circuits by connecting them in pairs to one secondary circuit, each of which is connected in turn to a liquid metal-water heat-exchanger with associated boiler plant and dump condenser. These form twelve independent heat-transfer units such that a fault on one will not affect operation of the remainder, and with this number the sudden failure of one or two units would not cause an excessive temperature rise in the core. The dump condensers are cooled by sea-water supplied in duplicate mains from four diesel-driven pumps installed in a pump-house on the foreshore. A 15MW turbo-alternator is supplied from a steam mains common to all steam generators, but if it should trip or the power demand fall, then steam is automatically diverted to the dump condensers. Because of the isolation of the site and the severe winter weather experienced in the north of Scotland it was decided to have an on-site electrical supply and diesel generator sets are installed for this purpose. Each set supplies power for all the pumps in one heat transfer unit, so that twelve generating sets are needed and in addition six spare sets are installed to ensure continuity of supply. There are also six larger generating sets which provide power for auxiliary plant.

Despite these precautions to guard against failure to reject heat from the core it was still considered conceivable that a major accident to the plant outside the sphere could cause a complete loss of coolant flow through the core. A thermal syphon has therefore been installed, which transfers the shut-down heat of the core (1·8MW or less) from the primary circuits to convection air-cooled heat-exchangers outside the sphere by natural circulation only, with no dependence at all on electric power supplies.

The primary and secondary circuits have been charged with 70/30 NaK initially but have been designed for operation with sodium which is planned to replace the NaK at a future date. Because of the higher melting-point of sodium this has required additional trace and space heating to keep the sodium hot during reactor shut-down.

Primary Circuits

NaK coolant leaves the bottom of the reactor vessel at (Fig. 11) 350 deg. Cent, enters the primary-secondary heat exchanger and leaves at 200 deg. Cent. after which it passes through the electromagnetic pump, the thermal-syphon heat-exchanger and re-enters the reactor vessel. To prevent overheating of the electromagnetic pump windings the maximum allowable temperature of the coolant passing through the pump is 200 deg. Cent., and hence the pump has to be installed in the cool section of the circuit. Flow through a cold trap is obtained by connecting a 1in bypass loop from the pump outlet to the trap, with the return connected via an expansion tank to the main circuit at the inlet to the reactor vessel. Similarly, bypass loops are provided for the hot traps, but as the pressure drop through the trap is higher a ¾in diameter return connection is made to a low-pressure section of the circuit near to the primary-secondary heat-exchanger inlet.

The pressure at the coolant surfaces in the reactor vessel, expansion tanks, cold traps, hot traps and other vessels is approximately the same as the electromagnetic pump outlet pressure, and the pressure differential across

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§ Head of Electrical Machines Laboratory, Nelson Research Laboratories, English Electric Company, Ltd., Stafford.
‖ Director, Ewbank and Partners, Ltd., London.

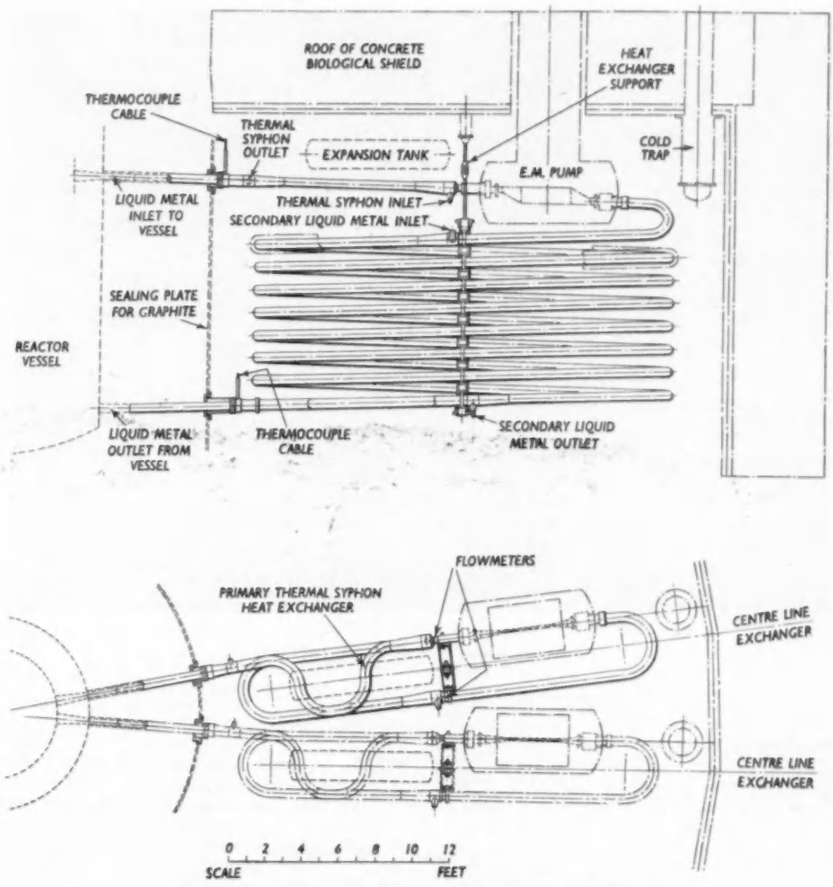


Fig. 11—Arrangement of primary-secondary heat exchanger

a pump at full flow due to the system pressure drop is 24 lb per square inch (11 lb per square inch through the core and 13 lb per square inch through a circuit). For efficient operation the inlet pressure to the pumps must be maintained above 12 lb per square inch gauge and this is achieved by pressurising the nitrogen blanket gas above the free surfaces to 50 lb per square inch gauge.

The primary coolant system contains 13,000 gallons or approximately 50 tons of NaK and expansion tanks are connected to the primary circuits to allow for expansion and contraction of the NaK as the temperature of the latter varies. Four of the expansion tanks are fitted with buoyancy type coolant-level indicators and six with blanket gas pressure transmitters. Originally each primary circuit was to be fitted with a cold trap in its associated bypass loop but as the design progressed it was found necessary, as described later, to remove nine of the cold traps in order to install hot traps and oxide measuring equipment.

The whole of the primary coolant system will become radioactive owing to the activity of the NaK and it is therefore completely enclosed in a 5ft thick concrete biological shield known as the vault. Certain equipment, such as the electromagnetic pump windings, the cold trap and hot trap internal parts, the level indicators and the electromagnetic flowmeters, will require to be removed periodically for maintenance and these items are therefore installed at the top of the primary circuits and supported from the vault roof with access through roof liner tubes. Normally these access tubes are closed by shielded plugs, but when required these plugs and the equipment can be removed by shielded flasks fitted to the reactor operating floor.

Extreme care had to be taken in the design to ensure that all circuits had a continuous slope to the lowest point in the system, that is, the bottom of the reactor vessel. At this point a filling pipe is fitted so that NaK introduced into the system will rise and displace gas into the blanket gas system. Alternatively the system can be drained by blowing the NaK back through the filling line to the dump tanks outside the sphere. To guard against loss of primary coolant due to possible corrosion or fatigue stress failure during the life of the plant, each primary circuit and the vessel are enclosed within a leak jacket. The volume contained by each leak jacket is filled with nitrogen and at the lowest point a probe type leak detector is fitted. Over the length of the primary-secondary heat-exchanger the outer tube of the heat exchanger itself replaces the leak jacket. Altogether there are twenty-five separate leak-jacket systems built and tested to the same standards as the primary-circuit pipe work and vessels.

Considerable attention had to be given in the design to stressing of the pipe work due to thermal expansion, and such stresses were kept low by a generous use of expansion bends. A network of steel supports is arranged on the underside of the vault roof, from which all pipe work is hung by suitably designed pipe hangers so arranged to be free to move in the horizontal plane to accommodate movement due to temperature changes.

Manufacture and Construction of Primary Circuits.—Extreme care was taken in the manufacture of pipe work and equipment to ensure the highest possible standard of fabrication. Tube billets were machined internally to remove flaws and stringers and after hollowing out were examined by "Intrascope" for defects. Six-inch diameter, nine-gauge tube for instance would be received at the tube mills in the form of hollows 6¼in outside diameter by ¼in thick and after two draws would be annealed, straightened and viewed against a fluorescent screen. If satisfactory a further three draws would be given to obtain final dimensions, followed by an air-under-water leak test, and a hydraulic pressure test at 800 lb per square inch gauge. The tubes were then finally viewed against a fluorescent screen and doubtful tubes were viewed by "Intrascope" before being accepted or rejected. The additional number of draws, and the viewing of tubes at an intermediate as well as the final stage, ensured as far as possible that the tubes were free of stringers, inclusions, and cracks.

Fabrication techniques were developed so that butt welds with radiographic examination only were used. For instance, to connect a branch pipe, a nipple was extruded on the main pipe wall to which the branch was then welded. To meet the requirement of oxide-free surfaces all welds were made using an argon-arc base run and argon-gas backing, and generally the base run was a fusion run without the use of a filler rod. Over 100,000 radiographs were taken in the shops and on site, and the identification and recording of these radiographs was a major undertaking.

The procedure for fabrication in the shops was to cold-bend the pipes as required and subsequently heat treat pipes above 2in diameter to 1050 deg. Cent. The pipes would be set up for welding and tacked together, and air was then purged from the inside by argon. This might be a complete purge of all the piping or a local purge made by plugging a section 6in each side of the joint using two rubber discs spaced 12in apart, with an argon inlet at one end and an outlet at the other. Immediately after the welding the joint was X-rayed using in the majority of cases the double-wall single-image technique. In many instances the 6in outer pipe had to be assembled over the 4in circuit pipe and a four-wall single-image technique was required, but experience showed that reasonably good results could be obtained. X-rays would show inclusion and porosity in the welds but fine cracks might escape detection so as a final check, the assemblies were gas tested using nitrous oxide and an infra-red absorption gas analyser. Finally the assemblies were cleaned by a light pickle in nitric and hydrofluoric acid solution, washed out with water, air dried and finally sealed with rubber caps before being despatched to site.

The sequence of erection of equipment inside the vault was carefully planned using a model, and every single pipe section and vessel was identified, allocated a storage position, and programmed for assembly, welding, X-ray and gas testing. In many instances it was not possible to return to a section previously erected once a later stage had commenced and therefore complete testing and rectification of faults had to be carried out before proceeding.

X-ray examination was a serious problem within the confined space of the vault since it was feared that all personnel would have to be evacuated from the vault during the examination. A solution was found by developing lead muffs, which surrounded the weld and enclosed the X-ray machine head so that the muffs did not fog the film owing to reflection and scatter, and this allowed personnel to work as close as 6ft to the machine. The nitrous-oxide leak testing equipment was too bulky for use

inside the vault and halogen-gas detectors using carbon tetrachloride were employed instead. All equipment inside the vault, with the exception of the hot traps, was erected within nine months and finally leak tested.

Primary Electromagnetic Pumps.—Each electromagnetic flat-linear induction-pump consists essentially of a flat thin-wall pump-tube on either side of which is clamped a linear stator. The stators are laminated and slotted. A three-phase winding arranged in the slots is supplied with current at 50 c/s and this produces a magnetic field travelling along the length of the unit. This field induces large currents in the liquid metal within the flat pump tube, and these currents, in the presence of the magnetic field, produce a steady thrust in the body of liquid metal, urging the latter through the pump tube. The pump thus has no moving parts, and since the pump tube is welded into the circuit, the possibility of leakage through the shaft seals needed by a mechanical pump is avoided. Stable control of the pump output throughout the range from zero to maximum flow is obtained by the simple means of varying the voltage applied to the terminals by means of an induction regulator.

Each pump operates within a deep steel pressure-vessel forming a leak jacket into which the stators can be lowered down guide rails on two sides of the access column, and then clamped on to the built-in pump tube.

The stators are clamped on to spacer blocks at each end of the pump tube, leaving a gap equal to the width of the tube, by means of a vertical screw and toggle gear which is preloaded in excess of the highest outward load exerted by the pressure in the pump tube.

The pump tube and diffuser assembly is made from two pressings butted together, and argon-arc welded along the top and bottom edges. Each tube is leak tested with a halogen leak detector, and the welds are fully radiographed. The tube material is 18/8/1 stainless steel, 0·080in thick. Substantial copper sidebars are brazed along either side of the pump tube ; these serve the same function as the end-rings of a squirrel-cage rotor winding. Finally, the flat sides of the completed tube are temporarily supported by flat steel plates bolted to spacer bars, and the assembly is given a hydraulic pressure test. The diffuser asymmetry allows liquid metal to be fully drained from the circuit if necessary. Spring tensioning gear prevents the development of compressive stresses in the pump tube as the main pipework expands.

The insulation of the pump windings has to meet two conditions :

(1) The winding temperatures resulting from a liquid-metal temperature within the pump of 200 deg. Cent. Since the containers are lagged, virtually the only heat sink is the flowing liquid metal. It was estimated that the hot-spot winding temperature would be 240 deg. Cent.

(2) The radioactivity of the liquid metal resulting from its activation in passing through the reactor core.

Class-H insulation and a newly developed inorganic insulation using asbestos tape and a heat-resisting cement were considered and the former was finally selected. Tests have shown that in a nitrogen atmosphere this insulation should have a life of at least five years under the conditions specified.

Pump stators can be replaced without disturbing the liquid-metal pipe work. Radioactivity is not induced in the stators, so that when lifted out and away from the vessels, the stators can be removed and replacement stators fitted to the clamp mechanism by normal methods.

At the design conditions the pump efficiency when using 70/30 NaK is 24 per cent but on changing to sodium the higher electrical conductivity of the latter will enable this to be increased to 32 per cent. The rather low pump efficiency is the price paid for the inherently leak-tight system resulting from the use of all-welded construction and no seals. At Dounreay there is no heat insulation between stators and pump tube, and the whole of the electromagnetic pump losses are transferred as heat to the liquid metal. It is worth noting that these losses are converted to generated electricity with the same efficiency as the heat produced by the reactor.

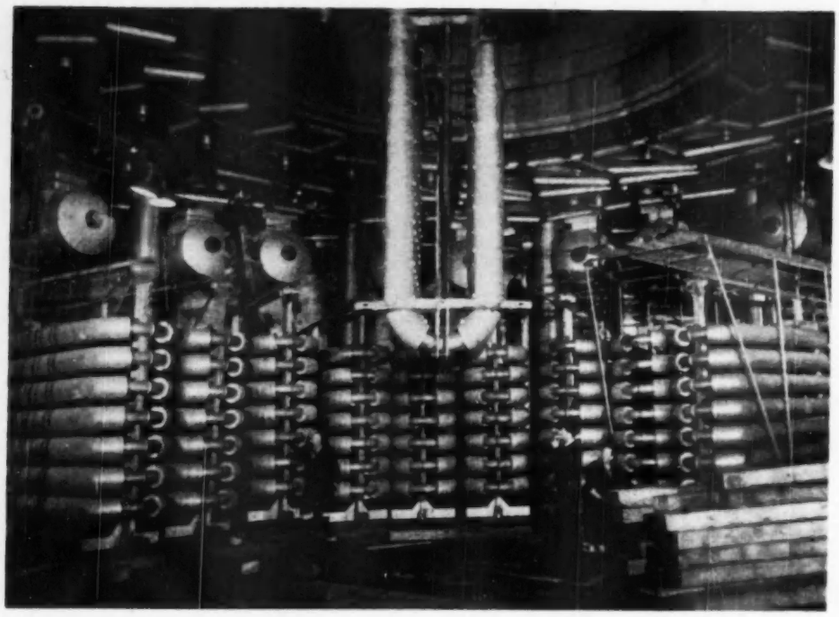


Fig. 12—Interior of vault during construction

The secondary pumps are of similar design and construction to the primary pumps but shielding plugs are not required and the access columns of the containment vessels are correspondingly shorter.

Primary-Secondary Heat Exchangers and Expansion Tanks.—Each exchanger has a heat-transfer duty of 3MW and consists of an inner stainless steel pipe 300ft long and 4in diameter, surrounded by an outer stainless steel pipe of 6in diameter formed into seven complete loops as shown in Fig. 11. The inner and outer pipes are held concentric by means of spiders machined from solid stainless steel and butt welded into the inner pipe. The secondary coolant flows through the annulus in contra-flow to the primary coolant. The centre point of each leg of the exchanger is clamped to a steel framework which is supported by a hanger through a pin joint from the vault roof, and allows the exchanger to move in a radial direction. The exchangers are lagged with 2½in thick mineral wool insulation covered with galvanised mild-steel cladding. In Fig. 12 is shown the storage of a number of heat exchangers inside the vault prior to being lifted into their final positions.

The expansion tanks allow for the expansion of the NaK coolant owing to varying temperature conditions and the total surface area provided is such that a variation of 3½in in level occurs when the primary coolant changes from its shut-down temperature of 150 deg. Cent. to its operating temperature of 350 deg. Cent. at outlet of the reactor vessel and 200 deg. Cent. at the inlet.

The tanks are constructed of two cylinders one within the other. The inner cylinder is made in 18/8/1 stainless steel. The outer cylinder forming the leak jacket is made in mild steel with stainless steel stub pipes welded on. Each expansion tank has a stand pipe welded on near the reactor vessel end and this pipe passes vertically up through the vault roof and terminates at a flange. Four of these flanges carry level indicators and six carry pressure transmitters, the remainder are fitted with shielding plugs and blank flanges. The complete assembly is supported from the stand pipe flange at one end and by means of a strap supported from the underside of the roof at the other end, this strap being pin jointed to allow for thermal expansion.

Primary Blanket Gas System.—It has already been explained that when the electromagnetic pumps are operating, the blanket gas system is pressurised to 50 lb per square inch gauge. The free surfaces in the reactor vessel, expansion tanks, hot and cold traps and other vessels are connected by 1in stainless steel tubing to a header outside the vault maintained at a temperature of at least 150 deg. Cent. This header is connected through vapour traps to six mild-steel buffer-vessels with a total volume of 1440 cubic feet. The vapour traps are cooled by air and in turn cool the nitrogen to 50 deg. Cent. at the same time condensing and collecting any sodium vapour which may be carried over with it. The buffer vessels provide sufficient volume to limit the variation of blanket gas pressure owing to changes of temperature of the NaK and gas under different operating conditions to 1·5 lb per square inch. The blanket gas may become contaminated with fission product gases so the buffer vessels are contained in a concrete vault 1ft thick attached to the main vault, and provision is made for shielding any exposed pipe work outside the vaults with lead if this proves necessary.

At shut down the blanket gas pressure has to be reduced below 0·5 lb per square inch and for this four of the buffer vessels are isolated from the main system and excess gas is pumped into them, raising their pressure to 82 lb per square inch gauge. The gas is then stored until required for pressurising the system again. Two of the buffer vessels are retained for buffer volume to ensure that

at shut down the variation of main system pressure is less than 0·3 lb per square inch per 20 deg. Cent. change in bulk temperature of the liquid metal. To reduce gas leakage to a minimum two diaphragm-type compressors with double stainless steel diaphragms are provided, rated at 8·5 cubic feet per minute and the time required for depressurising the primary circuit system using one compressor is 2½ hours.

The blanket gas system is designed and built to the same standard as the main circuit. The main sources of leakage are the flanged joints on the reactor vessel and primary circuit vessels, and wherever space permits use is made of double silicone rubber joints with an interspace manufactured to vacuum tight standards which allows the joint to be tested independently of the vessel.

Thermal Syphon Circuits.—A small heat exchanger similar in construction to the primary-secondary heat-exchangers is fitted to the top leg of each main circuit. The secondary sides of six of these heat-exchangers are connected by single 6in outlet and inlet pipes to the natural draught air-cooled heat-exchangers located in the stack outside the sphere. Altogether there are four independent circuits. The four air-cooled heat-exchangers are constructed of stainless steel tubes with aluminium fins shrunk on to provide additional surface area. Each circuit is fitted with expansion tank, cold trap, and flow meter and a common blanket gas system is provided. No trace heating is fitted as the circuits are charged with NaK eutectic alloy with a melting point of −11 deg. Cent. The four circuits are designed to remove 1·8MW which is the decay heat from the core thirty minutes after shutting down from a power level of 60MW and it is calculated that during this period the coolant outlet temperature from the core will have risen to a maximum of 465 deg. Cent.

Oxide Removal and Control—Paper 4 (of the symposium) describes the use of cold and hot traps to maintain the oxide content of the NaK at acceptably low levels.

Oxide contamination of the primary coolant system may occur from the following sources: (1) Oxide already present in the NaK when charging. (2) Contamination by impurities left behind from manufacture and construction. (3) Removal of oxide film from stainless steel surfaces which is not complete until a temperature of at least 350 deg. Cent. is reached. (4) Oxygen present in the blanket gas system. (5) Oxygen possibly introduced during charging of fuel elements and removal of equipment for maintenance.

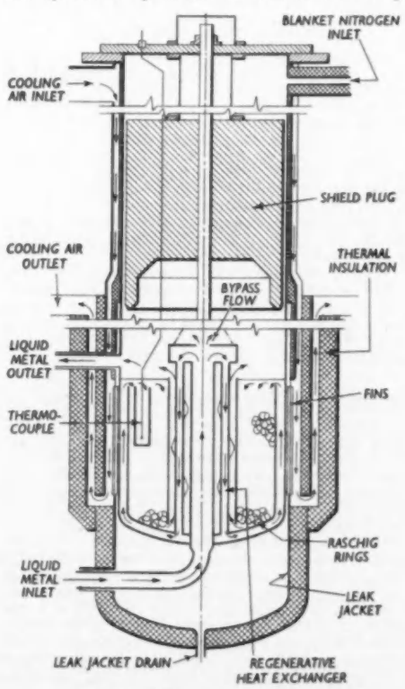


Fig. 13—Diagram of cold trap

Experience on the rigs gave very little indication of the amount of oxide which would have to be removed on a large-scale system either during the initial clean up or subsequent operation. As the maximum size of a cold trap in the vault was limited by the space available it was decided to fit a cold trap to each primary circuit. Later during the project it was determined in a rig that hot traps would be required to reduce the oxide level to below five parts per 1,000,000 (p.p.m.) in order to prevent excessive corrosion of the niobium and vanadium fuel-element cans. It was then decided to install five hot traps in place of an equivalent number of cold traps inside the vault, and as the life of the zirconium getter was not known, they were designed so that the latter could be renewed as necessary.

At the same time it was necessary to develop methods of checking the oxide content at these low levels. One method developed was to measure the relative rates of corrosion between niobium and stainless steel and a component known as the Oxide Corrosion Meter is being built for installation in the reactor. An alternative method is to remove a sample of NaK from the system and chemically analyse for oxide after distillation. The main difficulty with this method is to prevent contamination during removal of the sample of radioactive NaK.

For measuring the oxide content down to the limit of about 10 p.p.m. obtained by cold trapping alone, a plugging meter may be used. This consists essentially of a small orifice in series with a flowmeter and NaK cooler. When the primary circuits were being designed a reliable meter had not been developed, but such a meter is now being designed for installation on the reactor.

Two resistivity meters, under development, have also been fitted in cold trap vessels and these measure impurities in the NaK by change of electrical resistivity.[4]

Primary Cold Traps.—A schematic arrangement of a cold trap is shown in Fig. 13. The vessel is of single wall construction in the upper section and double wall in the lower to a point just above the highest coolant level. A section of the double wall portion is designed as a cooling surface with the interfaces sandwiching a layer of aluminium between them. Suitable grooves are machined in the aluminium to provide a leak path down to the leak jacket in the event of coolant penetrating the inner stainless steel wall. A finned bronze sleeve is shrunk on the outside of this compound tube to provide extended cooling surface.

Sodium-potassium at 200 deg. Cent. enters the cold trap at the bottom and flows up through the central tube and then down through the tubes of the regenerative heat exchanger which it leaves at 120 deg. Cent. The NaK then flows up past the compound tube where it is cooled by air drawn from the biological shield cooling-system and enters the basket containing "raschig" rings at 115 deg. Cent. This temperature is measured by a thermocouple and can be controlled by a damper above the vault roof in the air supply to the cold trap. After five minutes residence time in the basket the cold NaK enters the shell side of the regenerative heat exchanger and leaves the exchanger and the cold trap vessel at 195 deg. Cent. To ensure the correct flow rate of 0·26 lb per second through the basket a bypass orifice is provided at the top of the central tube, the size of this orifice being determined by rig tests on a prototype trap.

A portable lifting mechanism is provided, which at shut-down conditions with the blanket gas pressure reduced to 0·5 lb per square inch gauge, enables the basket to be lifted clear of the NaK.

Shielding from gamma radiation through the vault roof from the NaK is provided by an internal mild-steel plug, and mild-steel cylinders prevent streaming through the cooling air channels.

Hot Traps.—Each hot trap is designed so that 2·1 lb per second of NaK coolant from the associated primary circuit is by-passed through the hot trap, where it is heated to 600 deg. Cent. and passed over zirconium foil to absorb the sodium oxide. The trap consists of a main vessel with leak jacket, containing a heat exchanger, foil carriers, heater container tube and heater, arranged in Fig. 14.

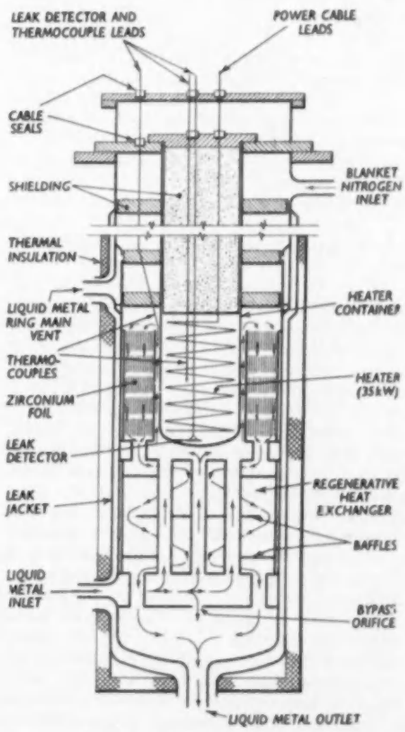


Fig. 14—Diagram of hot trap

The vessel is 22ft high and 1ft 3in diameter. In the lower section is a shell and tube type regenerative heat-exchanger where the incoming NaK is heated from 200 deg. Cent. to 580 deg. Cent. The coolant then passes over the 7in diameter heater container tube where it is finally heated to 600 deg. Cent. This tube extends to the top of the hot trap where a seal is made with the vessel flange. The heater unit, which fits inside this tube, is supported from a top sealing flange and consists of a stainless steel plug filled with heat-resisting cement for radiation and thermal shielding. The heating elements of effective length 6ft 6in are suspended from this plug and are constructed with 11 S.W.G. wire on ceramic insulators supported by a framework of high-temperature alloy studs.

The capacity of the heater is 35kW. Electric leads with ceramic bead insulation pass through the top plug in stainless steel tubes, and are connected through gas-tight ceramic seals to a junction box integral with the top of the container tube. The junction box is enclosed in a secondary container through which the external supply cables pass by means of "Pyrotenax" glands. With this arrangement the heater unit can be removed for maintenance without breaking into the coolant circuit but the space inside the heater container forms a secondary containment and is therefore filled with nitrogen and all joints are gas-tight.

The NaK then flows down through the foil container consisting or zirconium foil wound in the form of strips 3in wide 0·005in thick in alternate flat and crimped layers on to stainless steel bobbins 8in diameter. The crimping is $^1/_{32}$in deep. Twenty bobbins are spigoted together on the inside and encased in a stainless steel drum approximately 6ft long giving a total exposed surface of approximately 4000 square feet. The NaK leaves the foil container and is cooled to 220 deg. Cent. by the heat-exchanger before leaving the hot traps.

The flow of NaK is measured by a flowmeter in the by-pass loop, while a thermocouple measures the temperature of the NaK entering the foil container. This thermocouple automatically controls an induction type voltage regulator which supplies power to the heater to give a preset temperature. A thermocouple inside the heater elements provides protection in the event of overheating and is set to trip the power supply at 950 deg. Cent.

The whole of the internal assembly including heat-exchanger, heater unit, and foil container can be removed for maintenance by use of a special shielded flask.

Oxide Corrosion Meter.—The oxide corrosion meter is being developed for checking the performance of the hot traps in removing oxide from the NaK. When a measurement is required the NaK flowing through the meter is heated to 600 deg. Cent. and flows in parallel through two identical cylinders, one of niobium and one of stainless steel, drilled with 0·020in diameter holes. The rate of increase of flow through the niobium, compared with that through the stainless steel cylinder which has a negligible corrosion rate under these conditions, gives a measure of the rate of corrosion of niobium which can be used as a measurement of the oxide content.

The unit includes a regenerative heat-exchanger, electric heater, and control valve control block all mounted in one of the vessels originally provided for a hot trap. The complete unit can be removed by means of a shielded flask for renewal of the cylinders or other maintenance.

Sodium-Potassium Sampling Equipment.—This equipment is provided to obtain a sample of radioactive NaK coolant for analysis in order to determine the oxide content; 100 cubic centimeters of NaK can be taken in a nickel beaker from one of the vessels originally provided for hot traps. The NaK is distilled off, leaving the oxide in the beaker which is then treated chemically to determine the quantity of oxide present in the sample while the distillate is returned to the primary circuit. The whole process is carried out remotely inside shielded equipment.

Primary Circuit Instrumentation.—Instruments are provided to measure the coolant flow in each of the main and bypass circuits, the temperatures at the inlets and outlets of the primary-secondary heat-exchangers, the coolant level in the primary system and the blanket gas pressure.

Sodium-potassium coolant flow is measured by electromagnetic flowmeters in which a permanent magnet clamped across the coolant pipe sets up a magnetic field. The flowing coolant crossing this field generates a voltage and this is measured through a pair of electrodes welded to the pipe in a plane at right angles to both that of the flow and magnetic field. The voltage is proportional to the velocity of coolant and every flowmeter was calibrated in an out-of-pile loop. The magnets are positioned below a removable plug in the vault so that periodically they can be removed and the flux checked.

For temperature measurement standard chromel-alumel thermocouples are fitted into pockets machined out of forgings welded into the main circuit piping. The conductors are brought to the vault roof inside stainless steel tubing bent to a sufficiently large radius so that replacement can be effected without damage.

Coolant level indicators are fitted to four of the expansion tanks. They operate on the buoyancy principle and movement of the coolant is transmitted by cable to an electrical transmitter fitted to the top of the expansion tank tube above the vault roof. This transmitter is built to withstand pressure and is leak tight to vacuum standards.

Blanket gas pressure transmitters are fitted on top of six of the expansion tank tubes above the vault roof, and are again built to pressure and vacuum standards. Change in pressure is transmitted by a diaphragm to a liquid metal filled capillary inside the transmitter to which are connected three Bourdon tubes. These tubes either operate a magslip transmitter to indicate pressure variation at the receiving instruments in the reactor control room, or pressure trip relays to provide alarm signals.

Liquid-Metal Charging Station and Dump Tanks.—Arrangements were made to supply solid sodium in 4 cwt drums, and 50/50 NaK alloy and NaK eutectic alloy in 1 cwt containers. From this 51·3 tons of 70/30 NaK alloy had to be charged into the primary circuit, 64 tons into the twelve secondary circuits and 9·5 tons of eutectic alloy into the four thermal syphon circuits.

As the charging would be a "once off" operation it was decided to provide the minimum amount of equipment, and essentially this consisted of electrically heated muffs for the drums and containers, coarse and fine filters for removing impurities and a vessel heated to 150 deg. Cent. for mixing sodium and NaK alloy before discharging to the dump tanks.

Eight horizontal dump tanks 6ft diameter by 15ft long are provided in an underground vault outside the sphere, and are designed to contain radioactive coolant should it be necessary to discharge the primary circuit coolant. A 2ft thick concrete roof is provided for shielding, through which are installed level indicators, thermocouples, and heaters to maintain a coolant temperature of 120 deg. Cent. Initially these tanks are used for storing 70/30 NaK alloy received from the charging station prior to blowing over into the primary and secondary circuits.

REFERENCES

[1] Hall, W. B., and Crofts, T. I. M., 1956, *Proc. I.Mech.E.* Vol. 170, page 321, "Use of Sodium and Sodium-Potassium Alloy as a Heat Transfer Medium."

[2] Bannister, C. G., *et al*, 1954, Atomic Energy Research Establishment X/R/1381, "Report on the Proceedings of the Liquid Metal Utilisation Conference."

[3] Barrett, N. T., 1958, *Struct. Engr.*, Vol. 36, page 85, "Housing the Dounreay Fast Reactor."

[4] Blake, L. R., 1960, *Proc. I.E.E.*, Vol. 107, page 383 (Part A), "Resistivity Monitor to Indicate Oxide Content of Sodium."

(To be concluded)

Code of Practice

SOUND INSULATION AND NOISE REDUCTION

Code 3: Chapter III, 1960. Price 20s. "The best defence against noise lies in intelligent planning precautions taken before building development begins. If such precautions are not taken, the solution to sound insulation or noise reduction problems may be attainable only at very great cost, if at all." This warning can be said to sum up the recommendations published by the British Standards Institution on sound insulation and noise reduction in this B.S. Code of Practice.

The new code took a committee over two years to write and contains more than 100 pages of information and guidance which should make it essential reading for all concerned with town-planning and with building in its widest sense. It is probably the most comprehensive publication of its kind to have been published, the B.S.I. states.

Its first section sets out general principles for planning against noise which, it says, should be an integral part of Town and Country Planning proposals, first, by keeping noise at a distance (for example, the separation of housing from traffic noise by interposing buffer zones, protection of schools and hospitals by green belts, public gardens, &c.), and second, by interposing a less vulnerable building to screen one that is more vulnerable (for example, planning a factory so that offices and canteen blocks are interposed between the workshops and adjoining houses. The code then goes on to detailed consideration of sound insulation and noise reduction in residential dwellings, schools, hospitals, offices, industrial buildings and miscellaneous locations such as hotels, libraries and concert halls.

In each type of building the code examines the problem under the headings (*a*) outdoor noise, and (*b*) indoor noise and then makes recommendations for site planning and for detailed planning of the building. In existing buildings where the opportunity for proper site planning has been lost, a significant degree of noise-reduction could often be achieved by following the recommendations for this code.

Half the new code consists of a series of appendices giving data on the properties, behaviour, measurement, transmission, insulation and absorption of sound. Constructional measures for noise control are dealt with in great detail as regards walls, partitions, floors, doors and windows, ventilation systems, mounting for machines, open-air screen walls, and special sound-absorbent treatments using, for example, porous materials or resonant panels. Tables included in the code are those giving insulation values for walls and floors of various materials.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

IDENTIFICATION OF PIPELINES

No. 1710: 1960. Price 6s. This revised standard, with recommendations for a pipeline identification colour code, applies to pipelines in buildings, industrial installations and on transport equipment. British Standard ground colours are specified to distinguish between the various classes of contents—white for air, canary yellow for town gas, dark grey for chemicals and so on. Colour bands are specified to individualise within classes; for example, a pipe containing butane would be dark grey with a red band; one containing carbon monoxide would be dark grey with red and yellow bands. Lettering is recommended in certain instances.

Hazard markings have been introduced for use when the contents of a pipe may be radioactive, e.g. a pipe with a light orange ground and black diagonal crossed stripes would indicate the presence of heavily radioactive hazards. The standard includes five pages of fully annotated colour diagrams.

STEEL COLUMNS FOR STREET LIGHTING

No. 1840: 1960. Price 4s. This specification—now revised—includes requirements for columns made from steel plate, sheet and strip as well as from steel tube—the only material specified in the 1952 edition. Specifically, the eleven-page publication deals with the materials for and the design of steel street lighting columns with or without bracket arms. The columns, however, are not intended to support overhead wiring. Concise information is provided on: methods of construction; the fitting of the control gear, recommended depths to which the columns should be sunk into the ground; the connections for lantern fixing; protection against corrosion; and the maximum stresses and deflections permissible. Included is a list of fourteen items of information to be supplied when submitting inquiries or orders.

The Control of Parking

(CONTRIBUTED)

THE Traffic Engineering Study Group of the Institution of Civil Engineers met on December 8 to discuss Parking Control : the subject had been singled out for further debate from among the many aspects of the parking problem raised at the Group's meeting on March 29, reported in THE ENGINEER, April 8 and 15, 1960.

The proceedings opened with the presentation of a paper extolling the parking meter system and disparaging the disc system. " Provocative " was the word applied to this paper even by speakers who were not themselves provoked into dissecting it ; one of the dissenters asked that it should be banned from further circulation, and the author himself weakened so far as to welcome the idea of a trial of the disc system somewhere in this country in case it was only the Parisian temperament that had marred the system in his eyes. The meter versus disc controversy thus remains unresolved within the Group ; but the meeting brought to light a diversity of facts and authoritative views on parking, of special interest perhaps at this time, for London is still the only British city where meters are in use, though Manchester will start using them as soon as its four-shillings-a-day multi-storey park is ready as their complement, and a number of other towns and cities have recently procured authority for parking meter schemes.

To place meters in perspective more than one speaker emphasised that it would be wrong to say that any zone had been cured of its congestion by its meters ; the credit in that respect belongs primarily to the regulations, restrictions and limitations governing parking in the zone, and secondarily to the enforcement officers ; the task of the latter is made easier by devices such as meters and discs : that is all. And it is a great mistake, warned one speaker from abroad, to imagine that parking meter schemes can be infallible, or that meters are to any appreciable extent self-enforcing ; he judged that human nature is much the same in this country as in his, or worse ; about 15 per cent of the population will get away with whatever they can. Moreover enforcement only begins with the warden, meter-maid or other attendant who issues the ticket ; it has to progress all the way upwards to the courts, sometimes through machinery that is simply not geared to deal with the extra load, under which circumstances " ticket collecting " may become something of a hobby among the 15 per cent. The speaker seemed almost proud to have a friend whose score had reached thirty, and he told of a case being " settled for eighty " out of court, presumably, to help work off the backlog. But his broad indictment of parking meter schemes, based on surveys for which he had had some direct responsibility, appeared to be that they fail in their purpose when they are outgrown by the demand ; with only one space vacant in twenty-two cruising becomes as great a problem as ever ; and as saturation is approached so does the pressure to transgress soar, overloading the enforcement system and weakening it when it needs to be strongest so that there is yet more " getting away with it ": an instance of 9 per cent of the parkers monopolising 40 per cent of the space-hours was mentioned as only typical. However this speaker finally found one almost kind word for meters, saying that they are at their best on an off-street parking lot.

A number of disconnected historical points arose : meters were first used in the State of Indiana ; the possibility of using them in London occurred to a Ministry of Transport working party in 1951 ; the first 600 came into use in Westminster in July, 1958 ; by April, 1960, Westminster had 1822, along 15·8 miles of streets. The neighbouring borough of St. Marylebone brings London's present total to some 2300 ; expansion is afoot. The meeting was told that the initial Westminster zone had proved too small. When meters are introduced forty-six cars are permitted to park where previously some 100 used to park, and inevitably many of the excess fifty-four find a place in the adjoining streets, thereby worsening congestion in the area contiguous with the zone ; the cure for that congestion is to equip the contiguous area with meters, and expand the zone to include it. Such was the explanation given for the first expansion of the Westminster zone ; but no limits to the process were defined, and perhaps it was tacitly accepted that, as current events tend to confirm, expansion is somewhat inherent in street parking schemes. Reverting to the Westminster expansion, one speaker mentioned that a 1958 survey of the original zone had revealed an average of sixteen bays empty out of twenty-four, whereas nowadays, in his own experience of one sector of that original zone, there is seldom a bay vacant. Whether that was due to the widening of the zone or to the overall growth of traffic, it caused him to deprecate undue optimism over any apparent initial success in controlling parking ; the fundamental problem remains : it is the growth of traffic, exemplified by the figures for Central London's daily influx of cars—1951, 25,000 ; 1955, 43,000 ; 1959, 51,000 ; additional off-street parking will attract additional vehicles generating an increase in traffic as they come and go ; congestion will worsen in the controlled zones as elsewhere.

The length of meter bay in London is 20ft and several speakers sought to impress upon the meeting that this is the correct length ; there is no tedious edging in and out of these ample bays. But a less rigid view was taken by one speaker who preferred to make the bays fit the available street length, reducing their length, if necessary, though not below 16ft ; the 20ft marks could be retained, but would overlap, to ensure that the manoeuvring space is shared. It was mentioned that bays 22ft long, in Frankfurt, were visibly wasteful of street length ; and between each pair a third car would often creep in. The advice was tendered that the blank spaces for loading and unloading should be too few rather than too many ; commercial vehicles can use a vacant car space with impunity, but the reverse does not apply.

The meters chosen for London provide one hour for a sixpence or two hours for a shilling (or two sixpences) ; the profusion of sixpenny bits in the currency had influenced the choice, but simplicity remains the ruling consideration ; the police preference for simplicity was made very clear to the meeting after one of the speakers had described some of the almost unlimited variations that can be worked into a modern meter—at a price. For the uninitiated there was an eye-witness account of the working of the system in a certain London Square : car-commuters working in the surrounding offices arrive at 9 a.m. and insert shillings in their respective meters ; at 11 a.m. they emerge, drive round the square and park at a different meter, inserting another shilling ; at 1 p.m. they drive away for lunch somewhere presumably outside the zone, where parking will be free ; at 2 p.m. they are back, paying another shilling into a meter ; at 4 p.m. it is " musical chairs " again, and a final shilling sees them through to 6 p.m. when they go home ; so they get a day's parking for four shillings, which makes things difficult for the multi-storey garage round the corner which charges seven shillings a day. The propriety and legality of all this was queried, but the meeting was left in no doubt that it is happening, and at least it showed that those particular car owners are too law-abiding to remain using one meter, inserting coins in it more than once, which constitutes the offence of meter feeding. The other common offence of availing oneself of the " tag end " time left by the previous occupant of the bay, without freshening the meter with a sixpence of one's own, derives from a regulation that was said to be waivable by the local authority ; several speakers were for waiving it, none for enforcing it. To overstay one's time, by two hours or less, is no offence ; the resulting ticket entitles one to the compulsory purchase of this excess time for ten shillings, paid later to the local authority. Further overstayal constitutes an offence.

Mention was made of devices that can perhaps be substituted for meters : the automatic ticket vending machine that supplies a date-timed stamped label for display on the windscreen was held to be of promise for a string of kerbside bays no less than for an off-street park ; the portable, clockwork, season ticket sort of device, into which the purchased time is sealed, raises a special problem, the meeting was told. On parking the motorist would leave his clock displayed in the car so that the attendant could check that it was unwinding and had been set correctly for charge and time limit ; but the problem is that under current legislation this system would have to be free, like that other system—of which much was heard at the meeting—the disc system.

But would the disc system be truly free ? The meeting was told that the gross takings of Westminster's 1822-meter scheme amount to some £134,000 a year, yielding £50,000 profit, whereas the Parisians' fines are on a scale of about £400,000 annually per 1822 spaces in their disc zone ; moreover the burden on the courts is far less in Westminster where 92 per cent of the tickets for excess time come in punctually, with the ten shillings and without argument, whereas the comparable figure in Paris is only a little above 70 per cent. There was much emphasis on the £50,000 profit at the disposal of the local authority to subsidise off-street parking, though as a slight offset there was a mild warning from the overseas speaker who knew of places where meter schemes had started with their revenue earmarked in this way ; started but not continued. However, on the non-financial side the upholders of the disc system gave fully as good as they got. " If you decide you can spare one lane of a street for parking, why not let as many cars as possible use it ? " asked one speaker. The to-and-fro on that single question could no doubt have been prolonged indefinitely. The broad question of whether the system, in Paris and elsewhere, is a success or a failure, compared with the parking meter system, will be brought nearer home when some British town gives the disc a trial.

LETTERS AND LITERATURE

Letters to the Editor

THOUSANDS OF MILLIONS TO BE SAVED ?

SIR,—I have been very pleased to see the increasing interest in railway conversion and now the announcement that some 6 miles of railway are going to be incorporated into the Heads of the Valleys Road.

I hope that in the future the York to Market Weighton and Hull to Barnsley lines will be converted into roads and there will be widespread conversion throughout the country.

What does seem most important is that motorway regulations should be imposed on these new roads as this would cut accident rates by more than half.

W. D. MITCHELL

York,
December 10, 1960.

ASWAN HIGH DAM

SIR,—It would appear from the summary given in your editorial of December 2, of my papers, "Recent Developments in Nile Control" and "Storage Losses in the Nile Basin," presented to the Institution of Civil Engineers, that your correspondent has neither read these papers nor attended at their discussion, or else has entirely missed the theme of the papers and failed to follow the gist of the discussion. In particular your statement that virtually all the major criticisms brought up in the papers were challenged by speakers at the discussion is a misrepresentation of what has actually taken place. I therefore give below the fundamental issues brought out in these papers.

In the first place it has been proved beyond doubt that the method used in the official report for the determination of the reservoir capacity of the High Dam is basically wrong, and that in consequence both the capacity and losses have been greatly exaggerated, the former being estimated at 130 milliards of cubic metres and the latter at 10 milliards.

As a result of the correction I have introduced in the method of calculation, the capacity would have to be reduced to 65 milliards with a corresponding reduction in the losses. Since the height of the dam and indeed its entire design is determined by the size of the reservoir it holds, it follows that as a result of that correction the whole scheme will have to be revised. This fundamental and extremely important conclusion has not been even referred to in the discussion, let alone challenged, as implied by the sweeping statement made in your editorial.

Secondly, it is shown in the papers that only evaporation losses have been taken into account in the High Dam scheme, albeit using primitive methods and no field tests, while seepage losses have been ignored altogether. The results of the extensive investigation given in the second paper show that seepage losses are even greater than evaporation losses and may assume such dimensions as to reduce the Nile discharge reaching Egypt after the erection of the High Dam below its present volume.

Thirdly, the High Dam would create an immense lake covering about 1,000,000 acres, which would form a silt trap in which practically all the silt brought down by the river from its upper reaches amounting to about 134 million tons annually would be deposited. This silt has formed the soil of Egypt from the desert it was, and is still forming it from the desert it is, whenever an expansion of cultivation is envisaged, such as on the additional water to be provided by the High Dam. Not only will the High Dam deprive Egypt of that valuable soil fertiliser, but the clear water emerging from the dam would cause erosion in the river bed which might undermine barrages, bridges and other permanent structures on the river. None of these indisputable facts has been nor could be challenged in the discussion, though useful comments reflecting the experience of some of the speakers have been cited.

Finally, it has been shown that all the drawbacks of the High Dam would be eliminated by the use of Wadi Rayon depression for over-year storage which would perform all the functions of the High Dam in a manner that is more efficient, less costly and less wasteful of Nile water. Again this project has not even been discussed let alone challenged.

It is thus evident that, contrary to what your editorial would seem to suggest, the objections brought up in my papers against the High Dam are of utmost importance. For even if that project is insisted upon for one reason or another the entire design would have to be modified so as to correspond with the reduced capacity, thus effecting a saving of about 30 to 40 per cent of the total cost, and a reduction of losses to the extent of about 55 per cent.

Finally I would like to point out that the word actually used by the President of the Institution of Civil Engineers was that he welcomed the "courage" of the Author of these papers, for which you substituted the word "temerity" which is not quite the same thing.

A. AZIZ AHMED

London,
December 9, 1960.

ROSS MOTORWAY

SIR,—Looking at the aerial view of the Jay's Green interchange on page 932 of the issue of December 2, it appears that the entry roads are at right angles to the M.50 carriageway.

In view of the dangers caused to through traffic by vehicles entering and leaving I am surprised that acceleration lanes and deceleration lanes are not provided, as is the practice on most roads of motorway class overseas.

STEWART C. BLACK

Currie,
December 12, 1960.

ROUNDABOUTS AND TRAFFIC SIGNALS

SIR,—Your report of the discussion on the above subject highlights the fact that it is the capacity of junctions rather than the capacity of our roads which is the immediate problem. Any scheme which could increase the flow at junctions on our main roads without the vast expense of full-scale fly-overs should be considered. The writer would like therefore to put forward a scheme which he feels would increase the flow at junctions by anything up to 50 per cent.

It is based on the following facts.

(*a*) All private cars and light vans are never more than 6ft tall.

(*b*) Such vehicles never weigh more than 3 tons.

(*c*) They are all capable of negotiating a gradient of, say, 1 in 10 at a fair speed.

(*d*) All heavier vehicles are invariably 7ft or more in height. The writer cannot recall a vehicle in general use to which this does not apply.

Given these facts, the basic idea is to build light two-lane fly-overs over the existing roundabout and restrict their use to light vehicles which are not changing direction at the junction. All other vehicles would use the roundabout in the normal way.

Let us take as an example a roundabout at the junction of a North-South and an East-West main road with approaches of six-lane width. The two centre lanes would be carried up and over the junction with ramps of a gradient of say, 1 in 10. The East-West fly-over would continue at 1 in 10 up to the centre of the circle and then down again, while the North-South fly-over would dip down giving a clearance of 7ft where it passes under the other fly-over at right-angles. Clearance of 17ft would of course be allowed when the fly-overs pass over the existing circular road surface. It is difficult to visualise such an arrangement but a model has been made and when seen in three dimensions appears quite practical when the central reservation is 60ft or more in diameter. During "tidal flow" conditions it would be possible to use both lanes in one direction.

The most controversial aspect of the scheme would appear to be the method of sorting out the traffic units into their correct lanes before reaching the start of the ramps. The writer's solution is as follows :—

About 30ft from the start of the ramps a soft "loading gauge" would be hung from a post in the centre of the roadway giving a clearance of 6ft 6in. This would be made of material which would do the minimum of damage and make the maximum of noise when struck by a high vehicle and would be painted with reflecting paint. Being hung from the centre of the roadway it would enable the vehicle to regain its correct lane to the left without reversing. At the start of the ramp itself a rigid bar at 6ft 6in clearance would positively stop high

vehicles from entering the ramp. Warning signs and lettering on the road surface directing drivers into their correct lanes would of course be essential. This would only be a development of existing signs directing them into their correct lanes before reaching a conventional light-controlled junction. These appear to work quite satisfactorily.

At rush periods the proportion of private cars to commercial traffic rises considerably, and therefore a high proportion of traffic units using the junction at such periods would use the fly-overs, relieving the roundabout of much of the traffic, which would in no way be reduced in capacity due to the presence of the fly-overs. It should be pointed out that a fly-over constructed to take loads of only three tons would be vastly cheaper than a conventional fly-over which has to be constructed capable of taking loads of 150 tons.

It is not suggested that such a structure should be incorporated in a new road scheme, but the fact remains that roundabouts are proving more and more inadequate, and apart from vastly expensive conventional fly-overs, there appears to be no solution in sight—hence this suggestion for discussion.

D. F. C. VOSPER

Llandovery,
Carmarthenshire,
December 4, 1960.

Book Reviews

Using Centrifugal Pumps. By E. ALLEN. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 30s.

IN engineering there is a great difference of outlook between the trained technologist, with his thorough knowledge in some specialised field, and the so-called "practical man" who, often enough, has worked his way up to some executive position with a minimum of theoretical study. It is the professed purpose of this book to encourage the practical user of centrifugal pumps to interest himself in the simpler aspects of their operation and performance.

The author begins by describing the construction of conventional radial-flow single and multi-stage pumps and then goes on to deal with the testing of such units, and the evaluation and plotting of characteristic performance curves. It is a pity, in this connection, that the author restricts himself exclusively to radial-flow machines since the pump user may often encounter pumps of higher specific speeds, and a comparison between the behaviour of radial, mixed-flow and axial pumps would have been of value. Following a chapter on the method of establishing duty requirements, the characteristic curves previously obtained are brought into use for selecting a pump and for studying the effects of variations in the external circuit, such as by using twin discharge lines. The performance of pumps in series and in parallel is then considered, and various means of changing the speed of a pump are dealt with. The author chooses many of his examples from mining and fire-fighting practice, and a chapter on fire-fighting appliances is included.

Further chapters deal with cavitation and with auxiliary apparatus such as priming devices, automatic control, valves and gauges. The author specifically states in his preface that he is restricting his treatment throughout to pumps dealing with clean, cold water, but, later on, in a chapter entitled "Pot-pourri," he allows himself to stray from his self-appointed path and considers the handling of heavy and corrosive liquids, pH values, and the effects of variations in viscosity, much of which is the business of the manufacturer. There is a final chapter on installation and maintenance in which there appears, rather surprisingly, an illustration of a washery pump.

No useful purpose is served by most of the tables which fill the final twenty pages; a pump user cannot, surely, be concerned, for example, with the conversion of metric units, details of Unified screw-threads, and the weights of steel channels and angles. Furthermore, it cannot be necessary in a book which nowhere uses them to allocate four pages to logarithms and six to trigonometrical functions. One cannot overlook the fact that these, and other tables of largely irrelevant data, occupy up to one-tenth of the whole volume, and could have been entirely omitted without detriment to the remainder, and with a corresponding reduction in the size and price of the book as a whole. The typography and illustrations are of the standard one associates with the publishers.

The author has tried, more or less successfully, to be informal and conversational in his treatment all through, although there are occasional lapses into the facetious which seem out of place when dealing with a technical subject. The book deals with a few simple conceptions at considerable length so that it will be of limited value to the serious student of applied fluid mechanics. Its success or otherwise will depend on its appeal to a class of reader which is, on the whole, unused to buying technical books, and which is likely to be further discouraged by the price of the present one.

Spannbetonbau. Part I. By W. HERBERG. Leipzig: B. G. Teubner Verlagsgesellschaft, Leipzig C.1, Goldschmidtstrasse 28. Price DM.21.80.

THE work on *Prestressed Concrete Construction* by W. Herberg is divided into two volumes, of which the present first volume deals with materials and calculations, while the second part discusses actual design application in building and bridge construction. The theory is dealt with *ab initio*, and all formulæ are derived from first principles. The present second edition (the book first appeared four years ago) has been completely revised and brought up to date. Of the additional information incorporated there may be mentioned prestressing with wedges, and the use of expanding (supersulphated) cement, in particular in the U.S.S.R., as well as new tests of compound structures, high temperature tests of cables, and the design of large area anchorages. The book surveys modern practice on an international basis, and includes much information on developments in Eastern Europe.

Fundamentals of Rocket Propulsion. By R. E. WIECH, Jr., and R. F. STRAUSS. Reinhold Publishing Corporation, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 44s.

THIS is a relatively slim volume, but it covers the field of rocket propulsion quite thoroughly for a reader who does not claim any initial knowledge of the subject. In fact the authors have planned their text to "be of interest and value to lay readers as well as technical."

With this in mind the first chapter sets out to answer "What is a rocket engine?" This it does by descriptions of simple principles, references to well-known rockets, analogies and historical facts. All these are presented in an accurate and interesting manner so that the reader can absorb the ideas without effort. Then this basic approach is continued in three succeeding chapters which develop the ideas of reaction propulsion and the generation of action forces. Although the rocket engine is always in mind in these introductory chapters, it may be observed that a great deal of the text could have been written for any pre-engineering course. No doubt the careful explanations of engineering units, the relation between heat and mechanical energy, Newton's Laws of Motion the Gas Laws and so on are valuable to the layman, but most technical readers will want to slip quickly over this. Unfortunately, in so doing they may miss some of the rocket performance basic equations which are carefully worked into the text.

This will not be of vital importance in following the remainder of the book, as only minor references are made to performance aspects. There are chapters devoted to the liquid propellant engine, the solid propellant engine, future engines and a concluding chapter on rockets in space. These are again treated largely in a descriptive manner and it is not possible to find any serious faults in what is said. It may, perhaps, be remarked that a relatively long section is devoted to propellant pumps while combustion chambers barely get a mention in the discussion of the liquid engines. In the same way there is some unevenness in the treatment of solid propellant engines. Propellant manufacture, for example, has several pages, but motor casings have only a few lines.

Probably most engineers will find the chapter on future engines of particular interest. This contains descriptions of nuclear rockets, ion, plasma and arc jet units and finally photon rockets. Even these are presented in excessively simple terms and most technical readers will feel irritated by the promise of interesting material which is never fulfilled. The nearest the authors get to satisfying such readers is in the list of supplementary reading at the end of this and all other chapters. Here it seems that much of the recommended reading will mean a jump from one extreme of basic simplicity to the other of advanced specialist treatment. In spite of this, however, it must be agreed that the book does fulfil its purpose and should be of considerable value to the intelligent layman.

Books Received

General Dynamics of Vibrations. By Y. Rocard. Crosby Lockwood and Son, Ltd., 26, Old Brompton Road, London, S.W.7. Price 80s.

Power Stations Work Like This. Rolt Hammond. J. M. Dent and Sons, Ltd., Aldine House, 10-13, Bedford Street, London, W.C.2. Price 9s. 6d.

Colliery Year Book and Coal Trades Directory, 1960. Thirty-Eighth edition. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 40s.

Einfuhrung in die Technische Thermodynamik. By Ernst Schmidt. Springer Verlag, Berlin-Wilmersdorf, Heidelberger Platz, 3, W. Germany. Price DM.33.

Engineering Thermodynamics. By J. Jones. John Wiley and Sons Inc., Publishers, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 68s.

Aero-Thermodynamics and Flow in Turbomachines. By Michael H. Vavra. John Wiley and Sons Inc., Publishers, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 116s.

American Military Vehicles

PEFORMANCE CALCULATIONS AND DEVELOPMENTS

By R. M. OGORKIEWICZ

In an effort to obtain optimum performance in new military trucks, the U.S. Ordnance Tank-Automotive Command has resorted to the use of a digital computer to determine the overall transmission ratios. The work involved in this and its results are reviewed in the following article which concludes with a description of some of the recent American military truck developments, including the trend to lighter weight and the increasing use of aluminium.

CALCULATIONS of vehicle performance and their use to determine such design features as the overall transmission ratio are a relatively simple but rather lengthy process. In consequence, because of the time and man-hours involved, it is not always possible for designers to explore all the possible alternatives and thus attain optimum results. It is desirable, nevertheless, to cover the maximum number of possible alternatives, particularly where high performance vehicles are envisaged, and inevitably computers are resorted to increasingly frequently to help vehicle designers in their work.

An interesting recent example of the use of computers in this field is provided in a report on the " Digital Computer Utilisation in the Design of the Experimental Truck, 2½-ton, XM521 at Detroit Arsenal," by T. J. Bischoff and R. D. Arno, of the Ordnance Tank-Automotive Command, Detroit Arsenal, Michigan.

The report itself is marred unfortunately by very poor presentation, which leaves much to be desired from the point of view of clarity and completeness—even when it comes to such things as decimal points whose absence makes a considerable difference to one of the graphs of tractive effort *v.* speed. But, in spite of its shortcomings, the report is worth examining. It deals mainly with the selection of the axle ratio for the XM521, a new light-weight truck for which an experimental air-cooled engine and a modified commercial four-speed transmission had already been chosen. The approach to the problem consisted essentially of selecting several arbitrary axle ratios within the range of possibilities of the double reduction Spicer axle to be used and running the data through the computer, for which a programme had been written to calculate the acceleration performance and related characteristics of wheeled vehicles. The results supplied by the computer and its associated equipment in the form of printouts and automatically plotted curves provided a basis on which to evaluate the various gear ratios and decide which would provide the optimum combination of characteristics.

The axle ratio finally chosen was 6·90 : 1, and the resulting performance not only complied with the long-standing military requirements for tactical trucks of their being able to negotiate a 3 per cent grade at 30 m.p.h. with the rated cross-country payload and towed load and a 60 per cent grade with the rated cross-country payload, but also allowed continued operation over the whole engine speed range on each grade, under the stated load, without changing gear. That is, in high range third gear and low range first gear respectively, the available tractive effort curve lay wholly above the corresponding total resistance curve; in low range first gear the peak value of the tractive effort was actually 0·62 lb per pound of gross vehicle weight. (See Figs. 1 and 2.) Continued operation was also possible without changing gear on an 8 per cent grade in high range second gear. The maximum level road speed, fully laden with a 5000 lb towed load, was 58 m.p.h. and thus the performance met the other military requirement of a maximum speed of at least 50 m.p.h. The axle ratio chosen also provided near peak acceleration, the calculated time to reach 50 m.p.h. from rest through the high range gears being fifty-three seconds. Although maximum acceleration was one of the desired performance characteristics, the ratio selected was somewhat lower than that which would have provided it, because of the other performance requirements.

The above figures are worth quoting not only as the outcome of the performance calculations but also as an illustration of the standards being aimed at in current military truck design. The actual method of calculating the performance was derived from well-known premises and in its detail followed the information presented by J. J. Taborek in his valuable compilation " Mechanics of Vehicles."[1] In particular, the equation for the acceleration of the vehicle, which was the basis of the computer programme, took the form :

$$a = \frac{\text{Tractive Effort} - \text{Resistance to Motion}}{\text{Total Equivalent Mass of Vehicle}}$$

$$a = \frac{T\,\xi\eta_t - [W \sin\theta + (0{\cdot}01 + 0{\cdot}0001V) + (C_D\,0{\cdot}26\,AV^2)]}{\frac{W}{g}(1{\cdot}04 + 0{\cdot}0025\xi^2)}$$

where

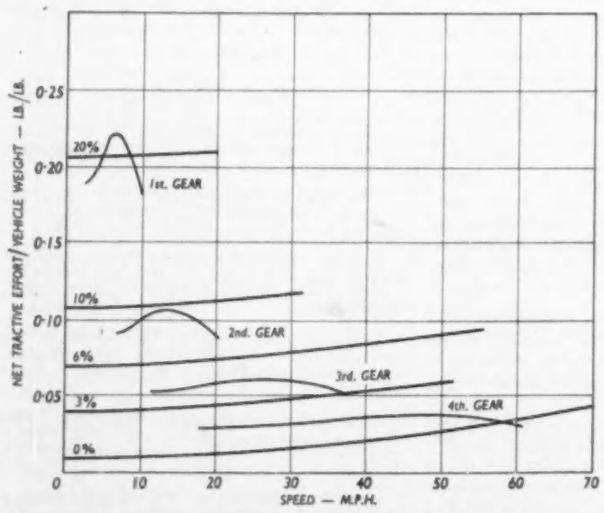
T—Net engine torque, lb-ft.
ξ—Overall gear ratio.
η_t—Transmission efficiency.
r—Tyre rolling radius, ft.
W—Vehicle weight, lb.
V—Vehicle speed, m.p.h.
θ—Grade angle, deg.
C_D—Vehicle air drag coefficient.
A—Projected frontal area of vehicle, square feet.

An essential factor in the above equation is the expression bracketed in the denominator which takes into account the inertia of the rotating parts; the factor is an empirical one and was actually put forward by J. L. Koffman as applicable to a number of vehicles.[2]

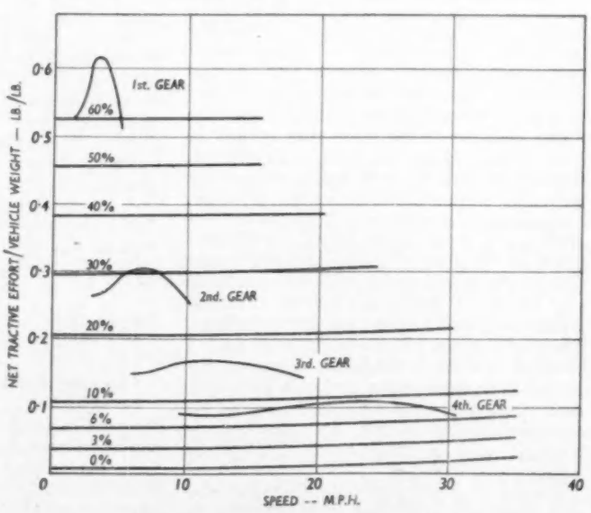
From the above equation a general programme was written for an Electrodata 204 " Datatron " digital computer to calculate the acceleration performance and related characteristics. Apart from the main " Datatron " computer and console, the equipment used to operate the programme consisted of a magnetic tape unit, a high-speed punch and/or wide carriage " Flexowriter " with format control, and a PACE " Dataplotter." The computer programme is illustrated in some detail in the report and is relatively straightforward. Data printed by the "Flexowriter " covered vehicle speed, distance

[1] Taborek, J. J., " Mechanics o Vehicles," *Machine Design*, Cleveland, Ohio, 1957.

[2] Koffman, J. L., " Vehicle Performance," *Automobile Engineer*, December, 1955.



XM521, 2½-ton truck, high range—50,000 lb towed load. Rear axle ratio, 6·90



XM521, 2½ ton truck, low range. Rear axle ratio, 6·90

Figs. 1 and 2—Net tractive effort/vehicle weight developed and required *v.* speed

travelled, time of travel, wheel torque, tractive effort, total resistance to motion, and drawbar pull as well as acceleration, and the PACE "Dataplotter" was used to plot automatically graphs of time *v.* velocity, time *v.* distance, and distance *v.* velocity. Other programmes have also been written which give plots of net tractive effort *v.* speed, drawbar pull *v.* speed, and other variables.

Solution to an acceleration programme requires approximately twenty minutes of machine time and twelve minutes for data printout. One can, therefore, obtain relatively quickly results for a wide range of design variables and for a fraction of the engineering man-hours hitherto necessary.

The accuracy of the results is largely dependent, of course, on the validity of the input data. On the basis of programme correlation with experimental results obtained

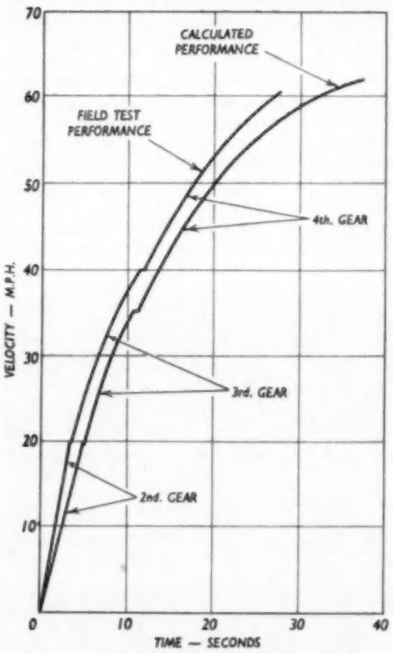


Fig. 3—Performance data: truck ¼ ton, 4×4, XM151

in vehicle tests the accuracy is said to lie within limits of ±5 per cent, which does not suggest any exaggerated claims being made for this method. One interesting example is actually quoted, for the XM151 light truck, and is shown in Fig. 3, where the calculated and experimental curves of velocity *v.* time are compared with each other. Some of the corresponding computer input data are given below and are of interest:

Number of gears used	Three
Vehicle weight (gross)	3700 lb
Tyre rolling radius	12·625in
Rear axle ratio	4·86 : 1
Rear axle efficiency...	100 per cent
Coefficient of friction between tyre and road	0·7
Maximum engine speed...	4200 r.p.m.
Engine shift speed	4100 r.p.m.
Gear shift time	0·25 seconds
Drag coefficient	0·96
Projected frontal area	21·18 square feet
Transfer case efficiency...	100 per cent
Transmission :	
Gear : First, Ratio : 5·712 : 1	Efficiency : 81 per cent
Gear : Second, Ratio : 3·179 : 1	Efficiency : 81 per cent
Gear : Third, Ratio : 1·674 : 1	Efficiency : 81 per cent
Gear : Fourth Ratio : 1·000 : 1	Efficiency : 85 per cent
Engine :	
Speed : 500 r.p.m.	Torque : 105 lb-ft
Speed : 1675 r.p.m.	Torque : 126 lb-ft
Speed : 3250 r.p.m.	Torque : 103 lb-ft
Speed : 4200 r.p.m.	Torque : 74 lb-ft

Military Truck Developments

The XM151 truck referred to above is of particular interest as it represents the latest development of one of the best known and most widely used American military vehicles, the ¼-ton, 4×4, Utility Truck, commonly known as the "jeep." This particular model has now dropped the experimental "X" prefix and is being produced for the U.S. Army by the Ford Motor Company under a 15,000,000 dollar contract issued about a year ago for 4050 vehicles.

The original "jeep," let us recall, was developed in 1940–41 by the U.S. Quartermaster Corps in collaboration with the Willys Overland Motors Inc. as a light, highly mobile personnel carrier and proved very successful in this and many other roles during the latter part of the second world war. The production at the time was entrusted to Willys and to the Ford Motor Company and the U.S. Army procurement of the original, 1940-designed model ceased in 1945. Three years later, when the operation of the original trucks was becoming uneconomical, a military requirement was established for a new and improved vehicle but for economy reasons the result was only a revision of the old design. Moreover, the military demand for additional equipment and modifications so increased the weight of the new M38 model that its performance was considered unsatisfactory and its production by Willys was limited. In consequence, a further improvement was produced by Willys : it used the same basic chassis as before and was heavier still but it was powered by a more powerful 72 h.p. F-head engine instead of the 54 h.p. side valve model previously used. This model, designated the M38A1 and easily recognised by its high rounded bonnet, was put into service during the mid-fifties.

In the meantime, towards the end of 1950, a new project was initiated with the Ford Motor Company for a ¼-ton 4×4 utility truck T122 and this has led directly to the current M151. The original design study completed in 1951 covered two alternatives: one followed the previous models in having solid beam axles and semi-elliptic springs, but the other had independent suspension all round. Otherwise, both were similar and had the general appearance and approximately the weight of the original "jeep." Of the two designs, the second was recommended and subsequently adopted, despite an estimated weight penalty, because of its superior overall performance. It is interesting to note in passing that during the design investigations an early model of the Austin-built F.V.1801 ¼-ton 4×4 truck with independent suspension was tested in the United States, but if it influenced American development the latter produced a vehicle weighing about 2300 lb against the 3640 lb of the F.V.1801A.

The front suspension of the M151 is of the double, unequal length wishbone type with coil springs and the rear suspension layout is of the diagonal swing axle type, also with coil springs. The production version differs from the original design in having a much shorter rear arm in the swing axle triangulation which produces greater changes in wheel camber, but this has had no adverse effect on tyre wear or stability and gives a less cumbersome layout. Other differences include the location of the brakes at the wheels in the production design, instead of inboard at the differential housings, and the use of conventional instead of pot-type universal joints.

Apart from its independent suspension, the other major features of the M151 design are the body-frame construction and the engine. In contrast to earlier models, the body and frame are integral, of pressed-steel spot-welded construction designed to accommodate load factors of 5*g*. The engine is a four-cylinder, o.h.v. water-cooled unit of conventional cast-iron construction but it weighs only 247 lb, or 3·5 lb per horsepower. It has a bore of 3·875in and a stroke of 3·000in, giving a total swept volume of 141·5 cubic inch, and has a gross output of 71 b.h.p. at 4000 r.p.m.; the compression ratio is 7·5 : 1. Short stroke designs such as this are no longer a novelty, but it should be remembered that the engine was designed ten years ago and was actually the forerunner of other, more familiar, short-stroke Ford engines produced in Cologne and at Dagenham. One other point worth mentioning about the engine is the use of a hollow, rifle-drilled camshaft to provide the main lubricating oil gallery, thereby saving some cylinder block metal and weight.

The drive is taken from the engine through a conventional, manually operated four-speed transmission with synchromesh on the upper three gears to a single speed transfer case enclosed in the same cast-iron housing. An automatic torque converter transmission was included in the original design investigations but was rejected as unnecessary and undesirable from the point of view of simplicity and light weight, which have consistently been the aims of the development.

The relatively light weight of the M151 has been achieved without resorting on any scale to light alloys and the original design actually deliberately adhered to ferrous materials. Since then, however, the body has been designed so that it can be made, without modification, in aluminium alloy if further weight reduction is desired. The design has also had to take into consideration the U.S. Army Ordnance concept of building a family of vehicles using as many components of the basic model as possible. This has been put into effect by the construction of the 6×6 ¾-ton XM408 truck which is basically the M151 with a lengthened chassis and a second rear axle. With its weight of 2870 lb, the XM408 compares very favourably with the standard M37 ¾-ton truck which weighs 5917 lb. A 1-ton 8×8 derivative of the M151 is also under consideration.

While the design and production of the ¼-ton 4×4 truck has passed on to the Ford Motor Company, a logical development in view of the quantities in which such a ubiquitous vehicle is likely to be needed, Willys Motors, Inc., have taken up other, more specialised designs. One is the M274 "Mechanical Mule," a small light-weight platform-type vehicle for use by infantry in forward areas, which was first revealed in 1954 and which has been put into service with the U.S. Army during the past year or two. This 4×4 model is powered by a special 16 h.p. air-cooled engine and can carry a load of 1000 lb, including the driver, yet it weighs only 830 lb. In this case the light weight and the exceptionally favourable payload to gross vehicle weight ratio have been achieved by the use of an extruded magnesium platform and cast magnesium wheels, as well as the use of aluminium amounting to 136 lb per vehicle.

Another vehicle being developed by Willys is the ¾-ton 4×4 XM443E1. This is an outgrowth of the M274 and, like the latter, is of the platform type. But, apart from being larger and having a 100 h.p. air-cooled engine, it has a parallelogram-type independent suspension with coil springs all round, whereas the "Mechanical Mule" has no springing other than that provided by the resilience of its tyres. The weight of the vehicle has again been kept to a minimum by the use of aluminium for such components as the tubular frame, wheels and platform, and is 2440 lb with accessories.

Aluminium is also used extensively in the

new model of the 2½-ton truck, historically the backbone of U.S. Army's transport. The new model, built by Chrysler Corporation and designated the XM410, is an 8×8 vehicle with independent torsion bar suspension and is powered by a Chrysler 361 cubic inch V-8 engine modified for military use. It weighs only 8600 lb of which about 2000 lb are aluminium components such as wheels, frame and body parts, and transmission housings.

All these vehicles reflect the striking progress being made in the United States in the development of lighter, higher performance military vehicles with much more favourable payload to weight ratios and better suited to transport by air, which forms an increasingly important military requirement. They also illustrate the progress made in the application of aluminium to vehicle construction. Aluminium has been one of the major contributing factors in the reduction of military vehicle weight and it has also seen a number of novel applications. Since 1956, for instance, aluminium armour has been under development in the United States. There is already one armoured vehicle in quantity production, the M113 Armoured Personnel Carrier, whose hull is made of aluminium alloy plates—Kaiser Aluminium alloy 5083—and several other aluminium alloy armoured vehicles are under development, including the T195 and T196 amphibious self-propelled howitzers and the T114 command and reconnaissance vehicle.

Australian Aeronautical Researches

THE Annual Report for 1958–59 of the Aeronautical Research Laboratories of the Department of Supply records further progress with some investigations of long standing and mentions some new lines of activity.

The work on fatigue, including the testing of complete " Mustang " wings, continues, and includes the testing of batches of ten samples of D.T.D. 363A and 24-ST under random loads in a rig that protects the remainder of samples from a shock load when one fails. Testing of de Havilland

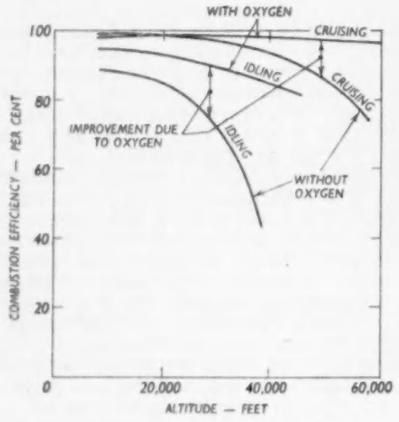


Fig. 1—Effect of oxygen injection on combustion efficiency in " Proteus " combustors

" Dove " wings in a vibration rig, repairing each failure as it occurs, had been initiated. An experimental investigation of the fundamentals of the fail-safe concept had led to the conclusions that :

(1) When cracks are terminated by stress-relieving holes the strength of the structure is slightly less than that predicted by elementary engineering methods ;

(2) When unrelieved cracks are present the structure may fail at a load about 20 per cent less than that predicted by elementary theory ;

(3) It is possible to determine the length of crack which will propagate for a given loading condition.

The chromium alloys for high temperature application have now aroused " substantial commercial interest " ; a high temperature turbine to test blades in service is still in course of preparation, but a severe programme of thermal shock testing has given excellent results. To investigate oxidation and corrosion due to fuel ash, a small turbine has been set up downstream of a combustor ; the formation of oxide scale at 1000 deg. Cent. is rather less fast than on a typical commercial alloy at 900 deg. Cent., but the adherence of the scale has been less good. In contrast with nickel-base alloys, very little grain boundary penetration of oxide occurs ; heating in air, however, causes grain boundary penetration of nitride, although there is evidence that certain additions greatly inhibit this effect. The investigation of ductility continued with emphasis on " scavengers " which would be expected to combine preferentially with nitrogen, and a strong alloy so treated showed ductility at —75 deg. Cent. Pre-straining in the ductile range has also been shown to force down the transition-to-brittleness temperature of recrystallised chromium, 3 per cent rolling at 400 deg. Cent. lowering it from 280 deg. Cent. to 0 deg. Cent.

Cyclone combustors with fuel distribution from a spinning cup or multiple-disc atomiser on the axis are being developed, and the trajectories of the fuel particles investigated. The full-scale tests of the oxygen lance have now been carried out in Bristol-Siddeley " Proteus " combustors ; the results are shown in Fig. 1, and confirm the prediction that for high altitude operation oxygen injection can effect a net saving in all-up weight. The fuel distribution effected by the injectors in this manufacturer's ram-jets has also been investigated.

Work has continued on wing-tip extension by blowing. Fig. 2 shows a 4½ per cent t/c

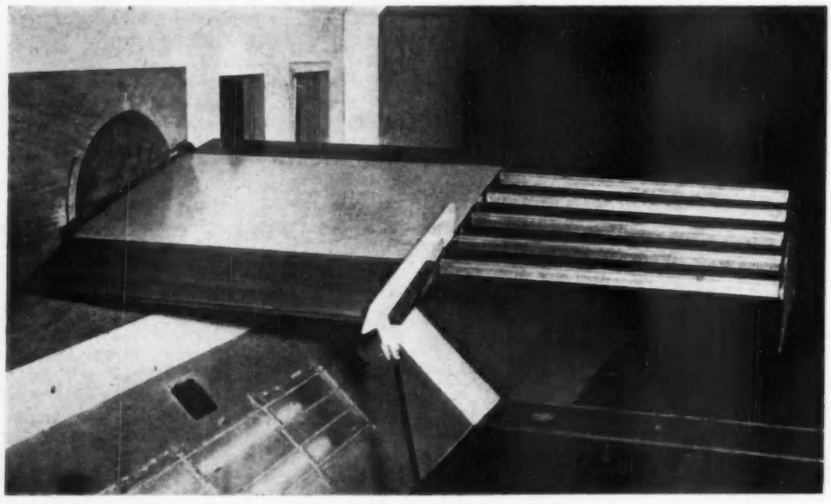


Fig. 2—Half-wing with tip extended by five tubes

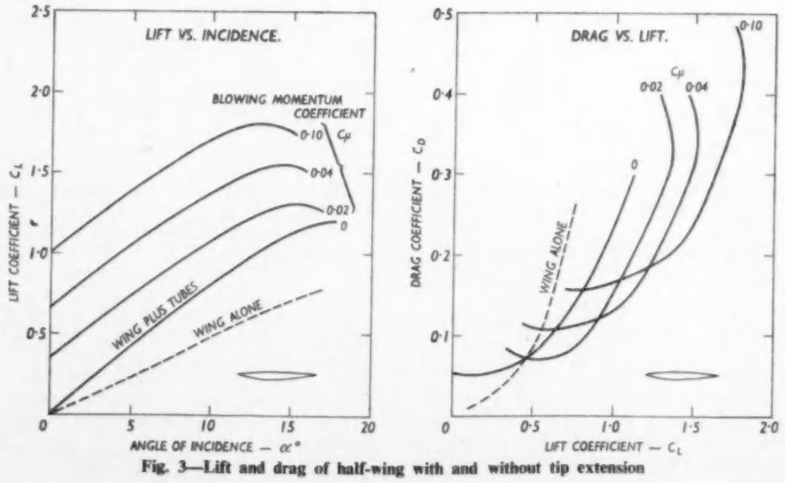


Fig. 3—Lift and drag of half-wing with and without tip extension

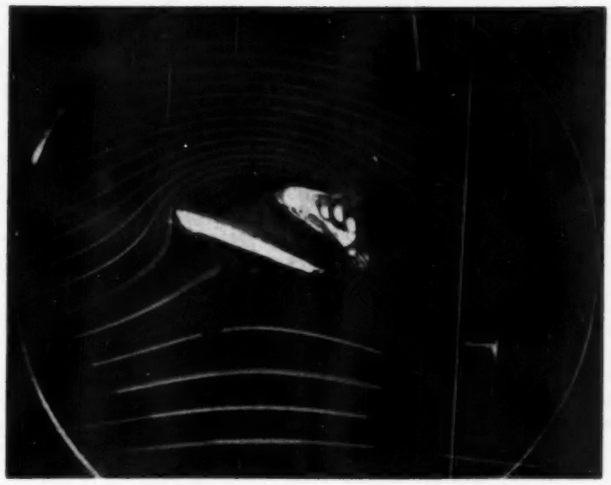


Fig. 4—Flow visualisation on wing with forward-facing flap. The white quadrilateral is the forward part of the upper surface of the wing. The shadow in the foreground is the boundary-layer-control air duct to the round leading edge of the flap. Under the flap can be seen pipes for tapping pressures at points around the flap.

bi-convex half-wing of aspect ratio $\frac{1}{2} \times 2 \cdot 0$ fitted with five extension tubes of length equal to 0·75 semi-span. Fig. 3, in which coefficients are based on the area of the solid wing, shows that the tubes by themselves exert an end-plate effect that increases the lift curve slope, and that at all but the lowest lift coefficients the optimum amount of blowing for maximum L/D is not zero. Tests with deflection of the nose and trailing edge flaps indicate that the increments of lift are at least maintained. Initial results show pitching moment characteristics generally similar to those of the basic wing.

The study of the detailed behaviour of detached flows has proved fruitful. Boundary layer control has been applied to re-attach the flow, and Fig. 4 shows the flow about an aerofoil fitted with a forward-facing "free streamline" flap. Full-scale work has continued with the Avro 707A delta-wing aircraft, and the report includes plots of drag-due-to-lift showing the two conditions of flow for a "clean" aircraft and measured values between and below these lines achieved with roughness, turbulator and different piloting techniques. Wind tunnel tests show that the "hysteresis loop" between C_L decreasing and C_L increasing may be as deep as 15 per cent C_{Di}; this behaviour is associated with the presence of a small step in the surface of the wing.

An experimental comparison was made of the A.R.L. Precision Visual Glide path, in which the pilot aligns two bars of light on the ground, with the Visual Glide Path Indicator (see page 291, August 22, 1958) using twelve experienced airline pilots. The accuracies of the thirty-six approaches on each aid did not differ significantly, but nine of the pilots preferred the Australian to the British system, and it has also elicited favourable comment from PanAm pilots at Nandi (Fiji).

At the Government Aircraft Factories work has been resumed on the Airborne Approach Aid (A.A.A.) and recent progress has been very encouraging. The design centres around a cathode ray oscilloscope and an electronic vector computer which derives information from the airspeed indicator, a climb and descent indicator with very rapid response, and a manual setting of wind speed and direction. Signals of the flight director type are produced on the face of the oscilloscope and passed through a collimating lens on to a piece of plate glass which may be folded down in front of the pilot's eyes; a horizon bar, an angle of depression scale and an airspeed indication are presented simultaneously in a different colour on the same piece of glass. Flight tests of a very preliminary nature, using a modified gyro gunsight, were conducted early in the year and gave useful information on the kind of presentation required.

Mining Research Establishment

IN the course of a recent visit to the Mining Research Establishment of the National Coal Board, at Isleworth, Middlesex, we were shown some of the many investigations now in hand to promote the economic, efficient and safe mining of coal. This establishment collaborates with the board's Production and Reconstruction Department on underground trials aimed at identifying and measuring the factors that determine the performance of machines in typical mining conditions. In addition to actual research the establishment is also concerned with the preparation of materials and equipment specifications which have already led to the promotion of substantial savings in costs and materials.

Two investigations of particular interest in hand indicate the possibility in the foreseeable future of the unmanned coal-face with all cutting, loading and advancing of face supports controlled from a distant point or, indeed, in automatic sequence. A first step in this direction is the control of a mining machine to ensure that it follows the undulations of the coal seam whilst cutting. To this end there has been developed a coal sensing device which shows on a dial the amount of coal on the floor as a machine advances along the face. This device incorporates a radioactive source carried on the machine and immediately on top of the layer of coal left on the floor of the seam from which gamma radiation is scattered back to a geiger counter. The radiation scattered back can be related to the thickness of the coal layer on the rock strata below. It is stated that this device can measure a layer of floor coal up to 4in thick within $\pm \frac{1}{4}$in.

The first machine to be fitted with this equipment in this country, and possibly in the world, is a "Midget Miner" being used at New Lount colliery in the East Midlands Division to cut 2ft 3in of coal out of a seam approximately 2ft 7in thick. This machine moves on two skids in each of which a coal sensing equipment is mounted as close as possible to the cutting heads. The main body of the machine is coupled to the skids by four hydraulic jacks which are used to steer the machine in the vertical plane. Two meters, to be seen on the rear of the machine in our illustration, are connected one to each sensing device and show the thickness of the floor layer of coal. With reference to these meters the machine operator can control the position of the machine within the seam and avoid driving into the floor or roof as the seam undulates. As a further step in introducing automatic machine control there is now being developed a servo system to link the sensing device to the hydraulically operated steering jacks and thus eliminate the need for manual control.

Another application of this coal sensing technique which is being examined is in the location of coal seams by using a sensing probe for logging boreholes which may be of normal shorthole size. With such a development the pattern of a coal seam could be determined by boring a relatively few large core-holes and a number of small drill holes which are much cheaper to drive.

A development which might well be eventually linked with this means of automatically steering a coal-cutting machine is a system of remote control for advancing powered face supports. This system reduces the time taken when advancing a face by advancing and resetting the roof supports under push-button control from a panel set in the supply road at the end of a working face. Preliminary underground experiments have been carried out at Measthan colliery to establish the feasibility of sequential hydraulic control of powered face supports and preparations are now well advanced for further extended trials. Two systems are to be tried; in one the movement of the supports will be entirely controlled by hydraulic circuits and the other will use electro-hydraulic techniques which it is thought may lead to greater flexibility of operation.

For such a system of remote operation of powered supports to be satisfactory, the operator in the gate road must have information that the individual supports have been advanced and reset correctly against the roof without the necessity of a man going along the face to examine them. An intrinsically safe instrumentation scheme to give this information has been developed for a face containing up to 256 support units.

For some time investigations have been carried out in ploughing as a means of winning coal, as this system has economic advantages as well as the attraction that it produces coal in the large sizes that are desirable. Some difficulties have arisen in practice, however, as the German ploughs most widely used have been designed to work with coals which are softer than those in this country. For this reason research has been undertaken to determine the important characteristics of machine and coal which decide the ploughability of a seam. An operational plough has been fitted with instruments to measure the two primary forces—that in the chain and the resultant force acting as the cutting head—whilst a production cut is being taken. Wire resistance strain gauges used as the force sensitive elements are fitted in the appropriate members of the plough structure and signals from these gauges are taken by a cable to amplifying and recording equipment situated on the gate road. These trials have provided valuable data on haulage forces and frictional losses. At the same time work is proceeding on the development of new designs of plough heads.

To reduce the need for the installation of ploughing equipment in a mine for testing purposes, an instrument has been developed to measure the strength of coal in a seam and determine its suitability for ploughing. This instrument, known as a "Penetrometer," can be seen in use underground in our illustration. It consists of a steel rod, of $\frac{1}{4}$ square inch cross-sectional area, which is pushed into the coal-face by a hydraulic ram. The force exerted in this operation gives a graph showing load against penetration and the results can be correlated to give the performance which can be expected from a coal plough without any need for expensive installation trials with a machine.

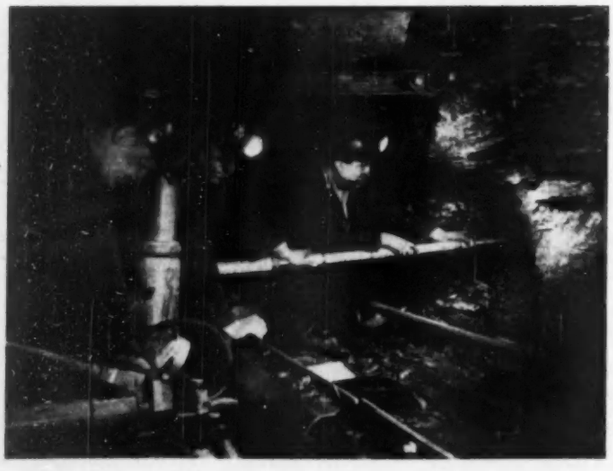
Another method being developed to test the

ploughability of coal consists of taking a large sample block from the seam and measuring its strength in tension. An expanding wedge type foundation bolt is inserted in a drilled hole in the coal block. When the bolt has been expanded to give a firm hold a tripod is set on the coal face and a spindle from the tripod centre connected to the protruding top of the bolt. A load is applied to draw the bolt out of the coal and the effort entailed can be related to the possible performance in coal ploughing.

Instrumentation plays a very important part in the development of new techniques and machines and in determining precise information on conditions and changes which take place at the coal-face and elsewhere in collieries. For these purposes a large selection of instruments and recording apparatus has been developed in the M.R.E. laboratories. These instruments include amongst many others load cells for measuring loads on props and on roof bolts, an extensometer for measuring change of strain on a rock surface, and a bore-hole plug for measuring change of stress at the end of a bore-hole. These instruments are based on the use of the wire resistance strain gauge and readings are taken by means of intrinsically safe measuring instruments also developed at M.R.E. The non-electronic instruments developed include a "Romometer" for measuring relative movement between roof and floor and a hydraulic cell for measuring loads on packs. A "Sonic" gauge developed for measuring strains in concrete linings of shafts and roadways can be incorporated in the concrete mass during construction to provide a permanent record of strain variations brought about by changing conditions in the surrounding strata. The tension on a length of fine wire in each gauge is varied by the strain to which the gauge is subjected by variations in pressure on the concrete. Strain measurement is effected by determining the frequency of vibration of the wire when it is plucked by means of an electro-magnetic impulse. This measurement can be made with accuracy and as the gauge is highly stable it can be used for readings over a period of years without fear of "zero drift."

Amongst a number of instruments developed to increase safety in working at the coal-face is a methanometer which is stated to indicate accurately to within 0·05 per cent the methane content of the atmosphere. In this instrument a small flame burning in a gauze protected enclosure, as in the Davy lamp, is fed from a reservoir of butane fuel. A precision pressure regulator keeps the flame constant and variations in the methane content of the atmosphere vary the "cap" above the flame. The presence of methane increases the temperature, which is recorded by built-in thermo-couples. The electrical output of the thermo-couples is used to operate an indicating meter on the side of the lamp or, via relays, remote recorders at any convenient station.

"Midget Miner" at New Lount colliery fitted with the nucleonic coal sensing unit. The dials of the two sensing units can be seen on the upper corners of the machine.



"Penetrometer" being used for evaluating the strength of a coal seam

Technical Reports

Automatische Regelung von Dampferzeugern, Dampf- und Gasturbinen. Berne: Verlag "Technische Rundschau," Hallwag Berne, Nordring, 4. Price S.Fr. 5.80—This publication, No. 23 in the TR Special Series, contains seven lectures given in December, 1958, on the occasion of the Zurich Meeting of SGA. In his introduction, Professor Dr. P. Profos refers to the theme of the meeting, which aimed at the discussion of details rather than that of general principles. Such treatment is of particular significance in view of the complicated mode of operation of modern steam generating plant, which as a rule requires several control loops. The "Calculation of the Dynamic Behaviour of Heat Exchangers with Analogue Computers" is the subject of Acklin's and Läubli's paper, which is followed by "Transfer Behaviour of Evaporative Pre-Heaters and its Influence on the Feed Control of Drum Boilers" (M. Schunck). H. R. Gerber deals with "The Control of Supercritical Sulzer Monotube Boilers," while "Control Experiments with a Velox Boiler" is the subject of A. Oberle. These papers are followed by "Control Problems in Steam Turbines with Reheat" (F. Flatt) and "Control Dynamics of an Open-Cycle Sulzer Blast Furnace Turbine" (Ed. Müller). Finally there is a paper by R. Boninsegni on "The Control of Turbo-Blowers Feeding a Steel Converter Plant through a Long Pipe."

The Effect of Structural Damping on Binary Flutter. By E. G. Broadbent and Margaret Williams. Reports and Memoranda No. 3169. H.M. Stationery Office. Price 8s.—The paper describes an investigation of the effect of structural damping in the torsion mode on wing flutter with the object of finding circumstances in which damping reduces the flutter speed. The drop in flutter speed can be considerable (25 per cent) and extend to very large values of structural damping. The effect is most apparent when the relative density (wing to air) is high, and when the wing bending mode involves a relatively large aerodynamic stiffness.

The rate of decrease of flutter speed with damping is small, and for the amounts of damping normally encountered in practice the effect is unlikely to be important. Possible practical cases are, however, part-full under-wing fuel tanks, which can supply high structural damping, and large tailplane amplitudes in the wing torsion mode, which can supply considerable aerodynamic damping; in both cases the effect could be appreciably adverse.

New Instruments for Measuring the Air Content of Oil. By A. T. J. Hayward, B.Sc.(Eng.). National Engineering Laboratory Fluids Note No. 91. N.E.L., East Kilbride, Glasgow.—The measurement of the air content of oil has been possible using an instrument evolved by Firth and Kane (see page 679, October 31, 1958) but this device is relatively expensive. Two new instruments have now been designed; one spreads the oil thinly over the flat bottom of a "casserole," and in the other the oil in a funnel-shaped vessel is agitated by a stirrer passing through a flexible bulkhead at the narrow end of the cone. With the former a determination takes from thirty minutes to more than one hour, increasing with viscosity, but in the latter evolution of air is complete in two minutes. The accuracy of these devices has been shown to surpass ± 3 per cent. There have also been evolved two sampling bottles, one closed by valves for use with oil under pressure or containing bubbles and the other having a screw cap.

Methods of Measuring the Bubble Content of Bubbly Oil. By A. T. J. Hayward. N.E.L. Fluids Note No. 92. National Engineering Laboratory, East Kilbride, Glasgow.—This report deals with methods of estimating the volume of the bubbles in bubbly oil; the term excludes foam, where the bubbles are not separated by relatively thick films of oil, and has no bearing on the measurement of the air content. It is pointed out that, as the bubble content is generally not stable in time, sampling technique is critical if representative results are to be obtained. It is concluded that three methods of measurement are useful and yield consistent results within $\pm \frac{1}{2}$ per cent. Where the oil is in an open sump, or is flowing in such volume that a vessel can quickly be filled, a hydrostatic balance measuring the apparent weight of a mass of known volume submerged in the oil is recommended; correction for temperature and solution of a simple formula is involved. Lower flows can be handled by diverting them into the working volume of a "deadweight apparatus"; when it is full a weight is applied sufficient to impose a pressure of 250 lb per square inch—the air in the bubbles dissolves and the decrease in volume is read directly. A slower but simpler apparatus consists of measuring cylinders calibrated in per cent total volume from the top down; they are filled and left to stand, the final surface level being at the mark corresponding to the initial bubble volume.

SHORTER REPORTS

Proposed Sites for South Coast Nuclear Power Stations

The Central Electricity Generating Board has completed its detailed investigations, which began in February, 1959, for possible nuclear power station sites at Earnley, Sussex, and at Hamstead, Isle of Wight. The Board finds that Earnley is technically unsuitable for development. Hamstead, on the other hand, is an excellent site, but, because of the amenity value of the West Solent, the Generating Board are considering an alterative way of providing more power in southern England at reasonable cost. It should be explained that the long-term national demand for electricity is increasing by 7 per cent per annum, but the rate of increase in the Southern Counties amounts to 10 per cent per annum. The loads of the Southern Counties can be met either by building stations on the south coast near to the areas where demand is rapidly increasing or by building stations in parts of the country remote from the area of demand, with transmission to the south coast. The Generating Board is reluctant to adopt the second alternative too widely because, for amenity reasons, it seeks to minimise the mileage of transmission lines and because the construction of power stations in the Midlands is not universally welcomed.

As transport charges on nuclear fuel are negligible, it is possible to generate nuclear power on south coast sites as cheaply as elsewhere ; it is for that reason that the Board has sought sites for nuclear stations on the south coast. Preliminary survey showed that between Dungeness and Weymouth there were only two potentially promising sites, one at Earnley and one at Hamstead.

An alternative development to meet the power demands of the Southern Counties while minimising transmission would be to build a conventional station on Southampton Water, but it has the disadvantage that a coal-fired station would increase materially the cost of power in the Southern Board's area as compared with alternative schemes. More time is necessary for the investigation and consideration of conventional alternatives.

Stationery Factory at Sawston

UNTIL about four years ago the Sawston factory of Spicers, Ltd., was run on traditional lines, but then market conditions and the related competitive position indicated that both manufacturing plant and techniques called for close examination as a prelude to radical modernisation. This problem was made the task of the engineering department, at Balham, which was responsible for maintenance and repairs and which was expanded to undertake the necessary development work. This went forward in three categories and the groups developed new machines, planned modifications in equipment from external suppliers, and prepared specifications for the modification of existing plant to improve productivity.

Most of the new ideas developed have stemmed from the refusal to accept traditional methods as being incapable of being performed by improved techniques. The result of such thinking has been a revolution in techniques and the evolution of new and more efficient machines. One such machine is the Monck blank cutter which cuts one wide reel of paper into four interlocking shaped webs of continuous pocket envelope blanks. These four webs can be rereeled ready for feeding the partially formed blanks into a new reel-fed pocket machine, specially evolved to take advantage of the technique, or separated into blanks at a rate of 900 per minute. In the Monck machine rotary cutters divide the four blank width reel into four webs with interlocking edge patterns which form the flaps of the pockets, the webs being staggered at half a pitch, and there is virtually no waste.

Another new unit is the siding, turning-in and gluing machine, which is in effect an automatic bookbinding plant. The machine has several stations linked together by transfer mechanisms. The first is fed with uncovered board-sided books and after they are gummed, leather cloth is applied from a reel and cut by a flying shear between continuously moving books. At the following stations the cover cloth flaps are turned over to the underside of the boards to bind the edges, and next the stiff covers are pasted down with the first and last leaves on to the insides of the covers. Then the books are pressed and gold blocked at two further stations. Saving of paper has been effected by a machine which overcomes the problem set by the need to notch envelope blanks for neat folding. This machine notches stacks up to 4in thick in two operations and the press incorporates four vertical pneumatic rams, two to cut the notches, one to round the corner of the bottom flap and one to hold the stack in position for cutting.

Large envelopes are cut at high speed by a Holweg paper bag machine which has been adapted to this purpose and is entirely automatic in operation. The first part of the machine consists of a high-speed rotary printing unit which is used for flap-gumming and three colour printing and in the next stage rotary tools perforate the reel : later the paper is burst along the perforation by two pairs of rollers having a controlled speed differential. Envelopes ranging from 18in by 14in to 3in by 1in can be made at speeds varying from 200 to 400 per minute. One of the new production lines is the Biclomatik machine, which was built in Germany to Spicers' specification and turns out spiral-bound notebooks at 1500 per hour in continuous and automatic operation. The equipment consists of a number of conveyor-linked units including a flexographic printing unit having eight printing cylinders, four notebooks wide. Following this operation the web is slit down the centre, cut into double width sheets, counted in an indexing drum and stacked. The stacks are blocked up, guillotined and punched along the top edge to take the spiral binding. Double width covers and backs are fed in and married to the stacks of sheets and then the double width books are slit down the centre and passed to the binding unit. All the operations take about one minute and finished notebooks are delivered at three seconds intervals.

One of the principal modifications made to existing plant was the changing of a cut-blank-fed banker envelope machine to reel feed to raise the production rate to 400 per minute and to cut waste. For easy folding there is a Spicers' developed persuasion unit in which the paper, prescored by rotary creasing tools, is guided into folds without interruption of flow.

These modifications, coupled with fundamental changes in the administrative system, the introduction of efficient materials handling, and the streamlining of the distribution arrangements, have resulted in a considerable saving in the value of the stock being held and release of capital for other purposes. It is also claimed that the first phase of the reorganisation has resulted in a 30 per cent increase in output with a reduced labour force.

Recirculating Ball Nut and Screw Units

A DESIGN of recirculating ball nut and screw assembly for converting rotary motion to linear movement, and vice versa, is now available in a number of sizes from the Precision Gear Machines and Tools, Ltd., Red Ring Works, Bodmin Road, Wyken, Coventry. The nut used in these units has an integral return passage in its body and the ball tracks are hardened and ground. The ball deflector, which is keyed to the body, has a hardened and ground deflection finger and is designed to present the same conditions to the circulating balls as in the screw tracks. To avoid a fretting effect each alternate ball in the circulating system is a load-carrying member and between each of these balls there runs an idler about 0·003in smaller in diameter.

The assemblies can be supplied with an integral preload to eliminate any undesirable backlash or, if required, they can be preceded with an adjustable preloaded nut. The nuts and screws can be designed to suit any lead which is practical for a ball track and for a predetermined load carrying capacity. It is claimed that horsepower requirements for operating equipment incorporating these units can be reduced by as much as 80 per cent when compared with conventional Acme screws and that their efficiency can be in excess of 90 per cent, whilst wear is negligible.

[Reply Card No. E10593]

Resistor Compositions

RESISTOR compositions which offer varied resistance values to provide greater flexibility in miniaturised circuitry are now available in Europe, as announced by Du Pont de Nemours International, S.A., Geneva. The result of a five-year research effort by Du Pont, the new compositions can be applied to ceramic dielectric bases by ordinary dip, brush or stencil techniques and then fired in a normal atmosphere to obtain a durable surface. With these materials it is claimed designers are no longer limited by the physical shape of resistors, which until now has been a problem in miniaturised circuitry. The compositions are available in three resistance values, viz. 500, 3500 and 10,000 ohms per square for a film one mil thick. These can be blended to obtain intermediate values. Tests are stated to have shown that the electrical properties of the new resistor compositions are reproducible and that fired patterns and coated rods have abrasion and impact resistance similar to silver coatings. The tests also reveal excellent stability under varying conditions of humidity, temperature, overload and voltage. The resistors are based on glass frit and metal powders and complement Du Pont's line of conductive silver compositions, which the company has sold to capacitor and electronic component manufacturers for more than twenty-five years. The matter states that compositions have a temperature coefficient of ± 350 p.p.m. per deg. Cent. from -55 deg. Cent. to $+125$ deg. Cent., a voltage coefficient of less than $-0{\cdot}02$ per cent per volt, and show a change in resistance of ± 1 per cent change after 250 hours at 95 per cent relative humidity (unprotected film). With standard short time overload, a change of $\pm 0{\cdot}5$ per cent is observed, and after 5 cycles of from -55 deg. to $+125$ deg. Cent. there is a change of ± 1 per cent, while ± 2 per cent change is caused by running for 1000 hours at 70 deg. Cent. at full load.

[Reply Card No. E10594]

International Boat Show

THE Boat Show which is organised by The Ship and Boat Builders' National Federation and sponsored by the *Daily Express* will be held at Earls Court from January 4 to 14, 1961. There will be a change of title which has been brought about by the demand for space from foreign manufacturers and the expanding list of overseas exhibitors. Under its new title "International Boat Show" there will be over 400 exhibitors and some 760 boats and marine equipment.

SHORTER REPORTS *(Continued)*

Vidicon Tubes

A TELEVISION camera tube which is sensitive to infra-red radiation is now being manufactured by E.M.I. Electronics, Ltd., Hayes Middlesex. This is a vidicon tube of standard dimensions, to fit into any ordinary vidicon television camera. The tube can also be used in a television camera in conjunction with an oscilloscope for temperature measurement.

Another new E.M.I. vidicon tube is sensitive to ultra-violet, enabling television pictures to be obtained from an ultra-violet microscope. Objects so small that they approach in diameter the wavelength of light can be detected by such a microscope and a visible picture can be obtained by using the tube in a television camera attachment. This enables the desired view for photographic recording to be selected visually, and has the further advantage that large audiences can view the subject simultaneously, if necessary at a considerable distance from the scene under observation.

[Reply Card No. E10601]

Boring and Turning Mill

AN elevating head vertical boring and turning mill is now being made by Webster and Bennett, Ltd., in three models with chuck diameters of 36in, 48in and 72in to swing work up to 46in, 58in and 84in respectively, the smallest machine admitting 40in under the cross slide and the two larger machines 48in. As shown in the illustration below the new mills are generally similar in design to the firm's conventional fixed slide machines but have an elevating cross slide controlled by a separate motor.

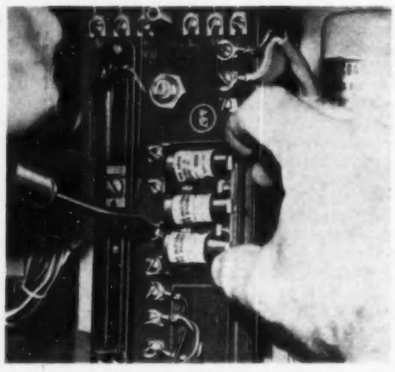
The forged steel indexing turret can be arranged for power rotation controlled by a push button and its slide can be swivelled to either side. A four-jaw independent chuck is driven by a large gear ring and pinion. A choice of twelve feeds and speeds available are selected by direct reading dials through a hydraulically operated change system. Four speed ranges giving from 3·8 to 300 r.p.m. are available for the 36in chuck machine, whilst there are five speed ranges available for the 48in machine covering from 2 to 192 r.p.m., and five for the 72in machine covering from 1·9 to 143 r.p.m.

All the controls for speeds and feeds, rapid power traverse and cross slide elevation are conveniently grouped on a panel at the side of the machine. The taper generating, screw cutting, electronic profiling and other attachments supplied for use with the maker's fixed slide machines can all be used on the elevating head machine.

[Reply Card No. E10602]

Adaptable Multi-Point Recorder

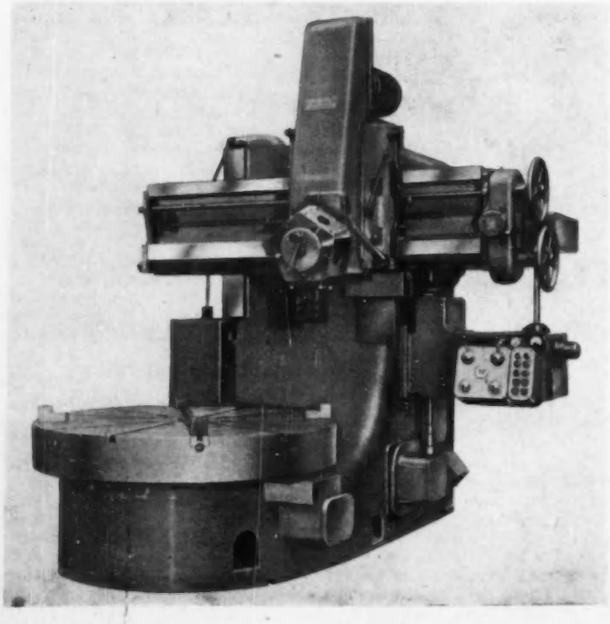
IN the latest version of the "Electronik" multi-point recorder of Honeywell Controls, Ltd., Greenford, Middlesex, provision is made for the measurement and recording of inputs from various numbers of points by inserting the appropriate print-wheel unit from a range of ten. Data from the selected number of points, between two and twenty-four, are then printed out in a repetitive sequence. Units can be removed for replacement by releasing a finger-tight nut, and the only other adjustment required



Replacing a resistor card to change range of multi-point recorder

is to insert a plug corresponding to the new unit in a multi-point printed circuit socket on the terminal board. This board is also replaceable to allow the use of different measurement devices. The range of the instrument can be changed by insertion of new resistor cards as illustrated. The cards are held by terminal screws which also provide the electrical connections, no screwing being necessary by the user in any of the processes described.

[Reply Card No. E10603]



72in chuck elevating head boring and turning mill

Microwave Components

Two new items of equipment for microwave engineering are announced by Aveley Electric, Ltd., Ayron Road, Aveley Industrial Estate, South Ockendon, Essex, the sole United Kingdom agent for all "Narda" products. One of these is a "Narda" broadband waveguide ferrite isolator, which is the first of a range of such devices shortly to be available. These characteristics promote the maintenance of signal source stability, and eliminate long line and frequency pulling effects in all kinds of low-power microwave signal sources. Four models are available so far, covering the "C" band, 3·95 to 5·85 mc/s; "XN" band, 5·4 to 8·2 Mc/s; "XB" band, 7·05 to 10·0 Mc/s; and the "X" band, 8·2 to 12·4 Mc/s. Average input for all models is 10W, and the peak input 2W.

The second item is a "Narda" digital readout attenuator (illustrated) which indicates

Digital readout variable attenuator for waveguides

directly the attenuation in decibels and tenths of decibels over a 60dB range. The movable "lossy" dielectric ridge is driven by a spring-loaded cam and the digital counter is geared directly to the camshaft for freedom from backlash. Models are available to cover the "X" band and "C" band.

[Reply Card No. E10604]

Institution Headquarters

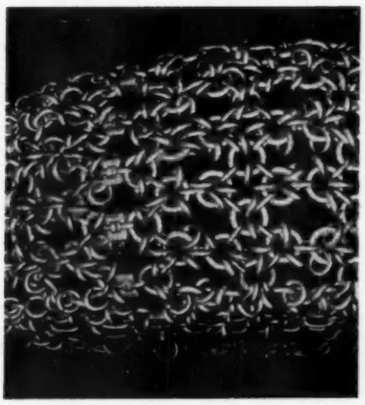
IN January, 1961, the head office of the Institute of Road Transport Engineers will move to 1, Cromwell Place, Kensington, London, S.W.7. The lease of the entire building has been acquired by the Institute and confers security of tenure for over thirty years. With office and residential accommodation totalling some 5000 square feet, compared with the 1000 square feet at present occupied at Victoria Street, the prospects for long-term expansion and development are extremely favourable.

The new Headquarters at Cromwell Place, conveniently located near bus routes and the Underground, will, in the first instance, accommodate the Council Chamber, Reception and Secretariat of the I.R.T.E. on the ground floor and basement areas. In due course, as the Institute expands its amenities and services to its membership throughout the world, the need to expand its headquarters will present no problem. Meanwhile, it is proposed to sub-let those parts of the building which the Institute has no immediate need to utilise.

Tyre armour being fitted to a wheeled loading shovel

Armour for Tyres

A FORM of chain mail to protect pneumatic tyres from cuts and impacts has now been made available by Bray Construction Equipment, Ltd., Feltham, Middlesex. The armour is intended for vehicles working on rough and broken surfaces, as in quarries and tips, where the life of tyres is limited by damage to the casing rather than wear of the tread, but it also improves the grip of the tyre on some surfaces. As our illustrations show, "Granite" armour resembles a snow chain of extremely close mesh, and is secured in much the same way at each side of the wheel, but in addition there is a series of clasps in way of the tread to keep the periphery of the armour closed. These joints are seen in the close-up; two half-links are inserted in the open body of the clasp and a nut and bolt fitted to prevent them being withdrawn. This link-up is described as self-cleaning, since the half-links project from the clasp and prevent deposits forming within it, while the clasp is not free to turn over, so that the bolt and nut are protected from being rubbed between tyre and ground.



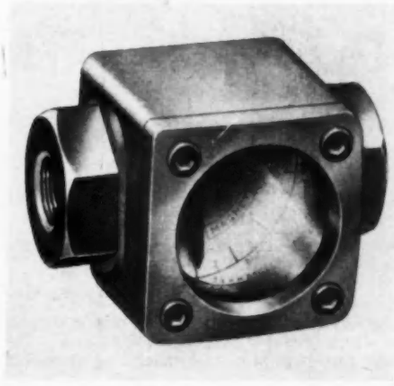
Close-up of "Granite" tyre armour showing the joints in the tread portion. Notice the symmetry of the structure, each of the rings in the plane of the tread having six other rings upon it, except at the ends

The armour is made from high-tensile manganese steel, and is available, we are advised, in a complete range of sizes.

[Reply Card No. E10611]

Flow Indicators for Opaque Liquids

AN indicator with which the flow of an opaque liquid through a pipeline can be checked, now being made by Sir W. H. Bailey and Co., Ltd., Albion Works, Patricroft, Manchester, is stated to be suitable for use with liquids of almost any viscosity and equally suitable for indicating flow either horizontally or vertically upwards. In these instruments, one of which is illustrated below, the fluid travelling through the chamber moves a hinged metal flap incorporating a magnet which operates a pointer against a scale. The pointer and scale are in a separate chamber so that the fluid cannot obscure the window.



Standard flow indicator for observing the flow of opaque liquids through pipelines

Internal parts of the "Magnetel" indicator, as it is known, are readily accessible for cleaning without removing it from the pipeline, and the instrument can be turned through 90 deg. if it is required to change the direction of flow. It is claimed that the indicator is adaptable for extremely low flow rates, and very small changes in relative flow are shown against the scale.

For use in systems where the liquid may contain ferrous particles which might adhere to the magnet, a special screened unit is available and in this design the magnet is enclosed in an intermediate chamber. Another model incorporates a switch which is operated when the flow stops completely or falls below a certain rate, to give audible indication of an emergency. The indicators are made in standard ½in, ¾in, 1in and 1½in sizes, with ends screwed B.S.P.T., and adaptors are available to match ¾in and 1½in pipes. A 2in indicator included in the range has flanged ends.

[Reply Card No. E10612]

Symposium on Pressure Vessel Research towards Better Design

ARISING from a suggestion made by the British Welding Research Association, the Institution of Mechanical Engineers is to arrange a Symposium on "Pressure Vessel Research towards Better Design," which will be held at the Institution on January 18 and 19, 1961.

The arrangements are being made by a committee appointed by the council, under the chairmanship of Mr. H. N. Pemberton, Member. The papers, about twelve in number, will be divided into contributions dealing with components and experimental research, and those considering design and design codes. The various papers will include reports on stress analysis investigations, design and testing of various components, pulsating pressure tests, fatigue tests, comparisons of various codes and probable future design requirements.

High-Power C.W. Klystron

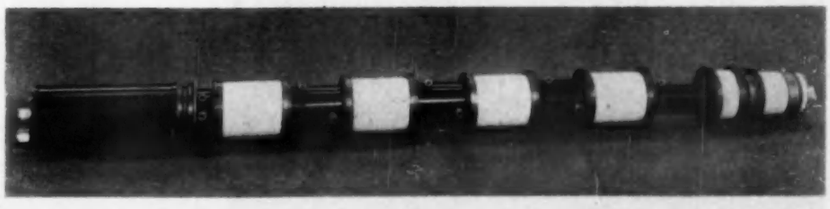
PRODUCTION has begun by the English Electric Valve Company, Ltd., Chelmsford, Essex, of a high-power tunable klystron which will deliver a c.w. output of not less than 10kW at an efficiency of 40 per cent. This valve (4KM50,000LA) is being manufactured from information supplied by Eitel McCullough Inc., U.S.A. It operates on 400 to 610 Mc/s and is mechanically tuned by means of external cavities. By keeping the tuning cavities completely external to the vacuum envelope, replacement costs at the end of the tube life are limited to the tube only. Repeated tuning operations can be performed without stressing or damaging the tube, so that besides providing flexibility of operation, the external tuning arrangement reduces the risk of failure.

An insulated modulating anode is employed which permits amplitude or pulse modulation of the output without changing the beam voltage and also provides protection when connected to the klystron body through a high resistance. The electron beam is focused by electromagnets and the focusing arrangement, the tuning cavities and the adjustable load couplers for the second, third and output cavities are supplied separately. The r.f. connections to the cavities are coaxial.

Among applications for the valve are Band IV television transmitters—especially in local television stations serving small, densely populated areas, because maintenance and replacement costs are at a minimum—and in u.h.f. scatter propagation.

The accompanying illustration shows the water-cooled collector at the left of the valve, and after this in order are the output cavity, two tuning cavities, input cavity and modulating anode. Apart from the collector, the valve is air-cooled, the cooling connections being visible in the illustration.

[Reply Card No. E10614]



Klystron valve with tuning cavities external to vacuum envelope. Overall length is 66in, and the mounting position vertical, cathode (at right) up

SHORTER REPORTS *(Continued)*

Compressed Air Filter

A COMPRESSED air filter, introduced by Doulton Industrial Porcelains, Ltd., Wilnecote, Tamworth, Staffs, is designed for a maximum working pressure of 250 lb per square inch and has a capacity of 30 cubic feet per minute f.a.d., at 125 lb per square inch system pressure. It has a casing of lightweight aluminium alloy and is fitted with a deflector on the inlet port to give the incoming dirty air an initial rotatory movement before it passes through channels and passageways at the bottom end of a conical-shaped baffle. At this stage the majority of the impurities are removed by the air being directed with a spiral spin against the inside wall of the casing. By making some of the air fan outwards at this stage there is formed an air cone which guards against carry-over or re-entrainment and causes the impurities to make their way downwards to the collecting zone beneath a plastic partition plate.

For final cleansing the air is passed through a porous ceramic filter element, elements being available in a standard 30 micron grade for normal purposes and a 5 micron grade to meet stringent requirements. These filters weigh only 1¼ lb and have ¾in B.S.P. connections in line so that they may readily be fitted into existing pipework layouts. No tools are required to remove either the body for cleaning purposes or the cover for access to the ceramic element ; normally, accumulated sludge and liquids are drained from the collecting zone through a quick-acting drain valve.

[Reply Card No. E10621]

Mobile Pneumatic Conveying Equipment

FOR some years F. E. Callow (Engineers), Ltd., Kirkby Industrial Estate, Liverpool, has specialised in the design and installation of pneumatic systems for conveying powdered and similar materials in pipelines between hoppers, mixers and other process equipment in industrial establishments. More recently the firm has developed a mobile pneumatic conveying unit which can be coupled up to temporary or permanent flexible or rigid piping at various parts of an industrial establishment for the transfer or feeding of materials. It is claimed that the use of this mobile prime mover considerably reduces the cost involved in installing a number of fixed conveyor and elevator equipments which are only needed in service for relatively short periods.

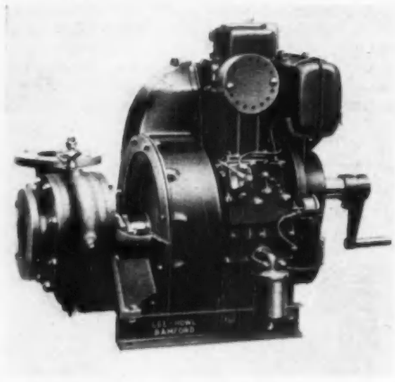
One of the new units, which has a capacity of up to 20 tons an hour, can be seen in the illustration with its side panel removed to show the ease of accessibility to the working parts. It incorporates a Roots compressor driven by a 25 h.p. motor and delivering up to 350 cubic feet of air a minute. The material passes through one of the firms' blower design rotary valves driven by a ½ h.p. geared motor, a pressure relief valve being incorporated in the system. The unit is connected through instantaneous couplings and flexible pipes to the intake and delivery lines of a conveying system. If required a diesel or petrol engine can replace the motor as a prime mover in these sets.

[Reply Card No. E10622]

Portable Pumping Set

A PORTABLE 4in low-lift, close-coupled, centrifugal pumping set introduced by Lee, Howl and Co., Ltd., Tipton, Staffs, in conjunction with Bamfords, Ltd., Uttoxeter, Staffs, is suitable for output ranges from 12,000 to 30,000 gallons per minute at heads from 59ft down to 22ft.

The power unit for this pumping set, to be seen in the illustration below, is a Bamford

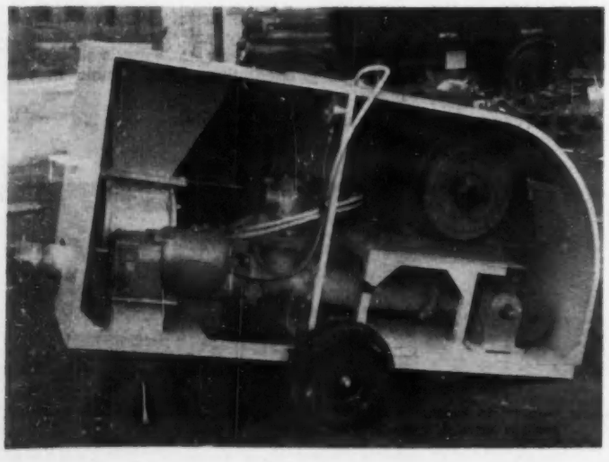


Portable pumping set driven by a 6½ b.h.p. diesel engine and suitable for outputs from 12,000 to 30,000 gallons per minute

single-cylinder, air-cooled diesel engine capable of developing 6½ b.h.p. at 1800 r.p.m. The headstock base, of special design, in high quality cast iron has an open top to permit access to the gland and allow free entry of air to the engine fan. Accurately machined spigots on this headstock register on the pump and engine to ensure accurate alignment, its feet being machined on the underside for attachment to the channel base, or a trolley frame, to support the pump.

The delivery flange of the pump can be arranged vertically or horizontally to enable the unit to be installed comparatively easily in different pumping positions.

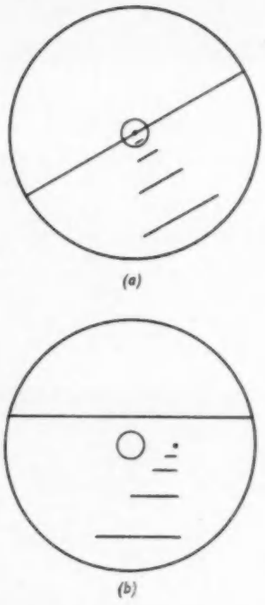
[Reply Card No. 10623]



Mobile pneumatic conveying equipment of 20 tons an hour capacity

Pilot's Information Display

A NEW form of instrument display particularly intended for "head up," or rather "head fixed," application has been evolved by the instrument and photographic division of the Royal Aircraft Establishment, Farnborough. The new display includes more information than the familiar gunsight or the Sperry flight director (see page 253, September 18, 1959), and instead of being formed by an instrument and then projected on to a screen it is composed electrically and becomes visible on the face of a high



(a) Aircraft banked to right in level flight : no demand
(b) Aircraft diving : demand for right turn

Steering and horizon display

brightness c.r.t. which is sufficiently brilliant to be visible in reflection. (An earlier example of this technique is mentioned in the A.R.L. Annual Report 1958–59: see page 1057). This method of generating the display allows—at a price—much more freedom in choosing the configuration of the presentation, and the opportunity has been taken to devise a display with an intuitive appeal, as compared to, say, a Zero Reader. The new presentation is shown in our drawings ; the attitude of the aircraft in pitch and roll is shown by a horizon bar, and demands for rate of climb or rate of turn are presented by a series of shorter lines parallel to the horizon bar which give the appearance of a track passing below the aircraft—when the demand is nulled, the vanishing point of the "track" is at the centre of the display. At present the display has only these four degrees of freedom, but conceptually it is possible to make available further degrees to indicate, for instance, skidding or slipping. The projection system removes the image of the tube face to infinity, so that the pilot does not need to refocus his eyes when looking from display to environment and back.

The new display has been installed and flown in a Gloster "Meteor," but in order to allow controlled experiments to be made to compare the effectiveness of this display with that of conventional instruments, a visual flight simulator has been built ; it is seen in the photograph opposite. The response to the pilot's controls is generated electrically and fed to the conventional panel, the "gunsight" c.r.o., and to the forward view simulator. The latter is of conventional construction employing a trans-

Visual flight simulator with display projector mounted above normal instrument panel. Notice the "roller blind" artificial horizon. The simulator appears to be making an approach to Blackbushe

parent landscape (see, for instance, General Precision Systems simulator described on July 1 last, page 35), and since flight is assumed to be always at a significant height a two-dimensional model such as an aerial photograph is adequate. The landscape is moved in front of the projector, not, as is customary, by a drive unit which reproduces the speed and heading of the aircraft, but by two drives fed with the $\dot{x}$ and $\dot{y}$ components of the track. The image on the screen is observed by a television camera which is so mounted that it can rotate to reproduce the effects of roll and pitch, and translate as the simulated aircraft climbs ; the output of the camera is then projected on a screen in front of the cockpit. Despite the image intensification potential of closed circuit television, it is necessary to use a very powerful light source and protect the transparent model landscape with heat filters and fans.

The question of whether or not a projected display on the screen spoils the pilot's contact flying can only be satisfactorily answered in flight or on a simulator which is sufficiently elaborate to reproduce the relative displacement of true and artificial horizons with change in C_L, the effect of cross winds in an i.l.s. approach, and similar effects. This may be possible in a more elaborate simulator now being constructed in which the cockpit has a limited freedom in pitch and roll ; to enhance the apparent validity of the simulation, arbitrary pitching and rolling inputs will be imposed when the pilot moves the controls. Since the screen is far nearer to the cockpit of the simulator than the landscape is to an aircraft, the projector has to be mounted on the moving element.

Ultrasonics in Gold Plating Process

IN many plating processes the reaction that takes place tends to "kill" the electrolyte round the component being plated, generating what amounts to an insulating barrier. One method of reducing this effect is to agitate the electrolyte with ultrasonic vibrations. We illustrate an experimental rig used in the development of a system for gold-plating commutators and slip rings. The ultrasonic apparatus was supplied by Dawe Instruments, Ltd., 99-101, Uxbridge Road, Ealing, London, W.5, the equipment in the illustration consisting of a Dawe Type 1150 500W/125W generator with type 1161/B36 immersible transducer.

The gold plating process in which this equipment is used is carried out by I.D.M. Electronics, Ltd., Whitley Kiln, Basingstoke Road, Reading, Berks, under licence from the Electro Tech Corporation in the U.S.A. It consists essentially of encapsulating lead wires in a cylinder of plastic which is cured and then machine grooved. One wire is locally exposed in each groove, and all grooves are then filled by a gold plating process and machined and polished to a surface finish of 4 micro-inches. Slip rings and commutators produced by this process are claimed to have great mechanical strength and excellent wearing properties, and to be little affected by wide changes in temperature and humidity.

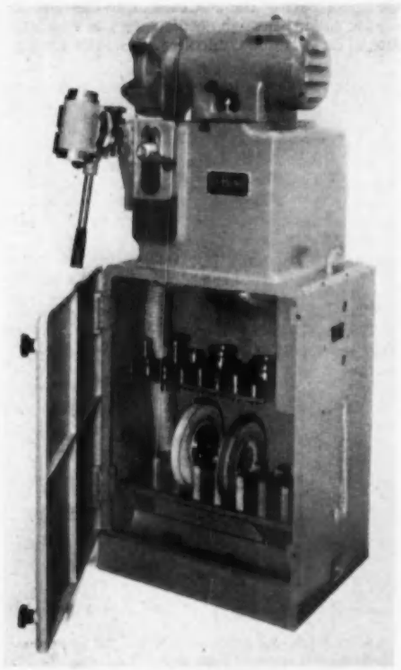
The I.D.M. production line equipment consists of a Dawe type 1152 2/0·5kW generator powering four 1160/B36 immersible transducers in the plating tanks. In the experimental set-up illustrated the wires visible are for suspending the plastic cylinders in the tank and to allow withdrawal without operators' hands coming in contact with the electrolyte while it is being agitated ultrasonically. The transducer is in the base of the tank.

[Reply Card No. E10631]

Gear Deburring Machine

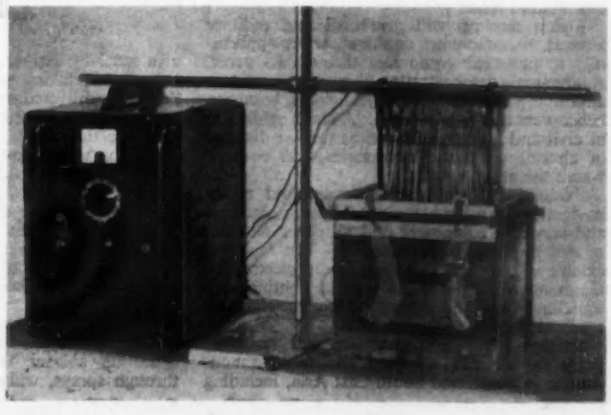
A GEAR deburring machine made by Burrows and Smith, Ltd., and now being marketed by Alfred Herbert, Ltd., Coventry, can be used to produce a precalculated chamfer on spur, bevel and helical gears (of up to 20 deg. helix angle) up to 12in diameter and of any tooth form. This machine makes use of a formed grinding wheel with a " worm " profile, a separate wheel being required for each different gear pitch and form. The gear to be deburred is mounted on the freely rotating spindle of a swivelling workhead which is raised to bring the gear into contact with the grinding wheel. Whilst the wheel then grinds the chamfer on the full profile of the teeth its worm form serves to rotate the gear and provide a continuous grinding process on all the teeth.

The pivoted workhead assembly, to be seen in the illustration, incorporates a stop to control the amount of gear in-feed during the grinding operation. It is operated by hand and to assist the " feel " into the wheel a spring-loaded ball in the stop is contacted before grinding actually commences ; in-feed up to the dead-stop is then continued against this spring pressure. The workhead has means of angular adjustment up to 30 deg. either side of the work spindle axis for deburring helical gears. A graduated scale is provided to facilitate accurate setting of the head angle, and the head is mounted on a slide to allow longitudinal adjustment of a gear across the face of the grinding wheel to enable its full width to be used. The workhead is adjustable vertically on the column of the machine and its setting, used in conjunction with the depth of cut control, determines the angle and size of the chamfer ground on a gear.



Deburring machine using a formed grinding wheel and suitable for spur, bevel or helical gears up to 12in diameter

Special wheels developed for use on this machine are made by the Norton Grinding Wheel Company, Ltd., and their structure is such that they should be scrapped and not reformed when worn. It is stated that in tests one of these wheels has deburred the single side of 100,000 teeth on hobbed gears. The machine incorporates a dust extraction unit with easily removable collection bags housed in a compartment at the rear of the base.

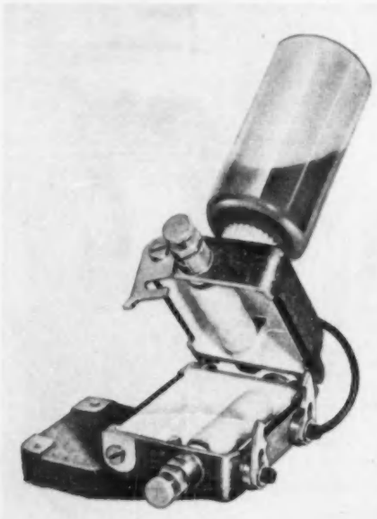


Ultrasonic generator and transducer for depolarising gold plating electrodes

SHORTER REPORTS *(Continued)*

Strip Oiling Device

WE illustrate an attachment now made by Clark's Press Equipment, Ltd., West Drayton, Middlesex, for the cleaning and oiling of strip materials before they are fed into power presses. It consists of a two-part hinged box having freely rotating felt rollers in the upper and lower halves which touch the top and bottom surfaces of strip as it is drawn through the box into the press tools. Lubricant from a bottle on the upper part of the box is fed into the cores of the felt rollers through needle valves by which the rate of flow can be controlled. The slot through



Strip cleaning and oiling attachment for presses; the upper half is swung back for the loading operation

which the strip passes into the box is fitted with rubber pads which clean any dirt off the material before the lubricant is applied.

The controlled feed of lubricant to the surfaces of the strip prevents the carry-over of excess oil to the tools and the hinged upper half of the box facilitates speedy loading of new strip into the machine. In addition to lubrication the device can be used for the application of degreasing fluid before follow-on operations on strip materials.

[Reply Card No. E10641]

Far Eastern Aviation Show

A NINE-DAY International Air Show, the first to be held in Singapore, will open on April 8, 1961, at Singapore Airport. Sponsored by the Singapore Government, is expected to be the most ambitious and comprehensive trade show ever held in Asia.

Flying displays will give civil and military aircraft manufacturers at the show an opportunity to put their equipment through its paces. A large-scale demonstration of naval and military aircraft is planned to include jet fighters, bombers, helicopters and light aircraft. A static exhibition of civil and military aircraft, as well as displays of aircraft parts and accessories, will cover a 7-acre site at the airport.

Exhibits also will include radio and radio-navigational equipment, aircraft spares, electrical and servicing equipment and all other facilities related to the aviation industry. The Japanese exhibit will consist mainly of radio electronics. Germany will show radar, airfield lighting, and signalling and electronic telecommunications equipment.

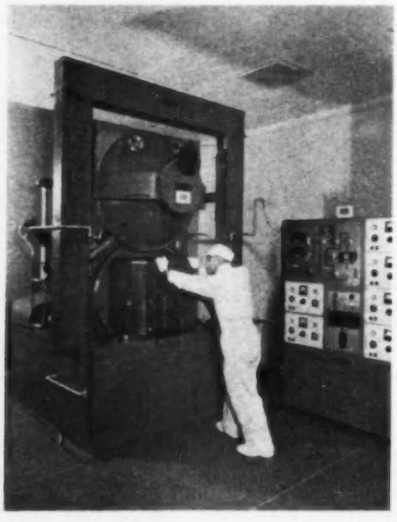
Singapore is the converging and radiating point for aircraft, shipping and telecommunications in South and South-East Asia, including Australia. It is also Asia's centre of tourism, commerce and industry. With the fifth largest seaport in the world, situated near the International Airport, Singapore is a centre for passenger movement to all points of the compass. Because of this strategic geographical location, the Singapore Government feels that the Aviation Trade Show—tying in with "Visit the Orient Year"—will play a vital part in helping European and American aircraft and aircraft accessory manufacturers to reach the increasingly "air-conscious" countries of Asia. The Singapore Government's official overseas representative for the Air Show is Mr. Alec J. Jones, managing director of Masters (1959), Ltd., 16c, Cecil Street, Singapore.

[Reply Card No. E10642]

"Nuclear Clean" Valves

To provide the "nuclear clean" equipment to the standards now being increasingly required by its customers Cockburns, Ltd., Cardonald, Glasgow, S.W.2, has installed an ultrasonic cleaning plant in its valve works. This cleaning plant is associated with a new clean conditioning room which is an air-tight structure of insulated steel panels with an air-lock door. An air-conditioning plant delivers clean dust-free air into the room and maintains a pressure of 2in water gauge above atmospheric pressure to prevent the entry of unfiltered air. A special fog filter has been incorporated in the air-conditioning equipment to counteract the atmospheric conditions which frequently prevail.

The cleaning plant built into one side of the room can be seen in our illustration. It consists



Valves and fittings for a nuclear installation being loaded into the autoclave in the ultrasonic and vacuum cleaning plant

of a specially designed autoclave with a revolving carrier, taking parts of up to 27in cube. Solvent is delivered on to the parts by sprays and transducers are fitted in the base of the autoclave for the introduction of ultrasonic waves. The autoclave is connected to a closed circuit solvent supply and drying system. This system, which is controlled by pneumatic valves, embodies storage tanks for preheating and conditioning the perchlorethylene solvent, a filter battery pump and ring vacuum pump. For recovery of solvent, there is a distillation plant comprising a still and a condensing unit situated outside the clean room.

The complete cleaning sequence is carried out in the autoclave. For the initial prerinsing operation solvent is fed into the autoclave through sprays, while the work carrier rotates to expose all surfaces of the component to the spray. The solvent is then recirculated through a filter battery for the removal of all solids in suspension and the autoclave refilled. A vacuum is applied and held while the generators are switched on introducing ultrasonic waves through the transducers. The carrier rotates during this operation to ensure complete cleansing. At the conclusion of ultrasonic cleansing the load is finally rinsed and the solvent drawn off before a vacuum is applied to dry the work. The vapour drawn off by vacuum is condensed in a cooling coil at the back of the equipment and returned for re-use. It is stated that on removal from the autoclave the work is perfectly dry and free of all dirt down to 1·5 micron filter.

When the components are removed from the carrier in the clean room they are assembled and sealed in polythene containers ready for dispatch.

[Reply Card No. E10643]

Plastic Pipe Coupling

A COUPLING for joining polythene pipe in service at pressures to B.S.S. 1972 : 53 without the use of tools has been announced by Hozelock, Ltd., Haddenham, Bucks. The "Tubelock" coupling is itself made of plastic, with a stainless steel spring around each ferrule, and thus does not compromise the compatibility of the polythene pipe with aggressive fluids. To make a joint, a knurled retaining nut is loosened, the pipe pushed in, and the nut tightened again, all with the fingers; pressure is then applied and the nut tightened finally. Couplings, elbows, tees, blanking caps and spare parts are available for ½in and ¾in pipes.

[Reply Card No. E10644]

Extension to a Roll-Making Works

A PROGRAMME of modernisation, extensions and re-equipment costing some £300,000 has been in progress during the past two years at the roll production shops of Armstrong Whitworth (Metal Industries), Ltd., Gateshead-upon-Tyne. When completed this scheme will increase by about 20 per cent the present annual output of 10,000 tons, or approximately 2500 rolls of various sizes. The foundry is still in process of reconstruction and work has been completed on a new building to extend the machine shop. This 270ft long by 70ft wide building is served by a 50 tons capacity overhead crane carried on rails 27ft above floor level.

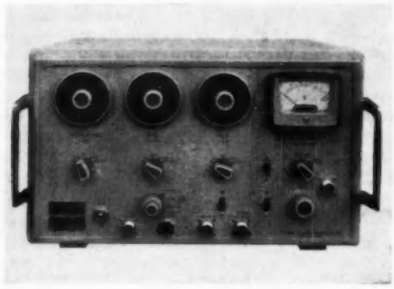
Four new machines installed to date in the new building include a 33in and a 40in centre Craven heavy-duty roll turning lathes. The first of these lathes is designed to machine rolls up to 25ft long and 55in diameter, and the second 28ft long rolls up to 64in diameter. Each lathe has three saddles, two at the front and one at the rear, and has a range of speeds and feeds to enable both high-speed and tungsten-carbide tipped tools to be used. The larger capacity lathe is fitted with a screw-cutting attachment for machining internal threads in the ends of rolls.

A heavy-duty Richards borer installed has a 6ft table, is used for machining steel and cast iron rollers. A Craven horizontal miller is used for machining the palm end or spade drives on large rolls. It can be adapted to mill both the side and end faces of a palm end, while an overhead arm can be attached for the machining of a spade slot. These operations can be performed with the roll remaining in one setting and face milling cutters up to 18in diameter can be used.

Delivery is expected shortly of a German built Herculese grinding machine to be used for the mirror finishing of the rolls made for strip and plate mills. This machine is to be installed in one of the older machine shops and will be capable of grinding rolls up to 40in diameter and 20ft long.

Single and Double Pulse Generator

THE decade pulse generator illustrated has been introduced by Solartron Laboratory Instruments, Ltd., Cox Lane, Chessington, Surrey, for purposes such as the accurate determination of transmission characteristics and transient response of amplifiers and networks, or testing the frequency and amplitude limits of electronic counters. It provides positive- or negative-going, single or double rectangular pulses of up to 100V amplitude at repetition rates from 10 c/s to 1 Mc/s. Three sets of concentric decade controls, with illuminated dials, permit coarse and fine adjustments of pulse duration, repetition rates and signal delay ; an amplitude monitoring meter is built into the instrument. Signal delay time, relative to a 10V prepulse output for triggering purposes, is variable over the same range as the rectangular pulse duration, namely 250 millimicroseconds to 100 milliseconds.



Decade pulse generator for amplifier network and electronic counter tests

In the double-pulse mode of operation the leading edge of the first rectangular pulse coincides with the prepulse and the leading edge of the second identical rectangular pulse occurs after the set signal delay. A delayed prepulse is also made available approximately 250 millimicroseconds after the prepulse, thus providing a trigger output which may be made to coincide exactly with the leading edge of the main rectangular pulse. Provision is also made for external triggering.

[Reply Card No. E10651]

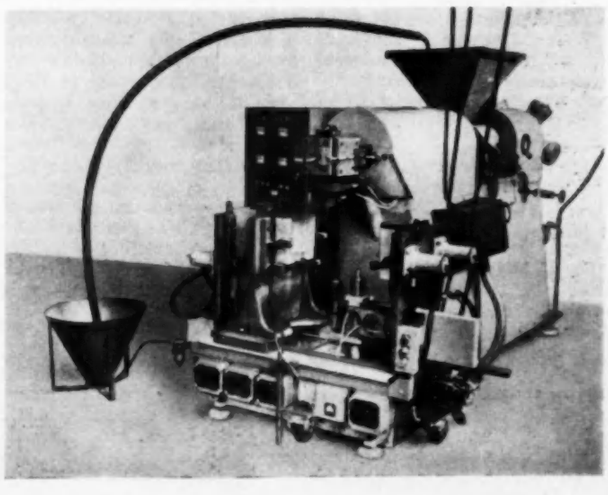
Blow-Moulding Machine

WE illustrate an automatic blow-moulding machine for polythene containers now made by the Amigo Machine Company, Ltd., Skylon House, Park Royal Road, London, N.W.10, to produce containers up to 9in diameter by 20in high. With this machine 40 oz containers with a material content of 4 oz can be produced at a rate of 250 per hour or 3-gallon containers with an 18 oz material content at up to fifty per hour.

The hydraulic drive of this machine has a 20 h.p. electric motor driving a five-cylinder radial motor connected to the extruder screw through an Oldham coupling and giving a stepless range of speeds from 0 to 100 r.p.m. In its sequence of operations a plastic tube is extruded centrally between two fixed mould halves. A platen carrying the mating mould halves reciprocates between the fixed mould halves, first closing one mould and then the other. At each transfer movement a knife attached to the moving platen cuts off a length of extrudate and traps it in a closed mould. Air is forced into the tube in the mould to form a hollow body. As the opposite mould is closed to repeat the operation on the other side, the completed article is ejected from between the open halves. The length of extrudate is determined by a photo-electronic unit which stops the extruder at each pass of the platen and also initiates each cycle of operation.

The machine can be operated with either one or two moulds and, if necessary, two containers of entirely different shape may be produced provided the quantity of extrudate required is the same for each.

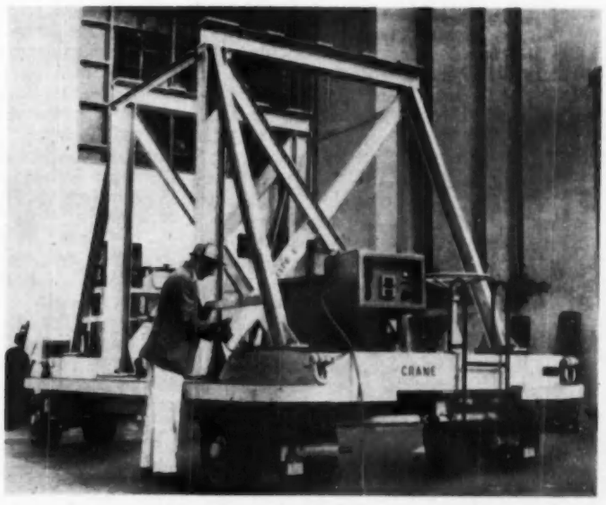
[Reply Card No. E10652]



Automatic extruder and blow moulder for polythene containers

Charge Face Transporter

THE firm of road trailer manufacturers, Cranes (Dereham), Ltd., has designed and built to the order of A.E.I. John Thompson Nuclear Energy Company, Ltd., two mobile transporters for use on the charge face floor at the Berkeley power station, where a tractor could not be used for towing purposes. The transporters had to be self propelled and independent of all connections, electrical or otherwise. One of these transporters, which only has to travel a distance of some 40ft in any one move, is illustrated below.



Creeping transporter on the charge face floor at the Berkeley power station

The chassis frame is built up of two box-section main beams with boxed and channel section cross members, and it is mounted on four pairs of solid rubber-tyred wheels with compensating axle beams. At one end a vertical pivot is fixed to the chassis frame, and from it the wheels are steered by a large handwheel via chain gear and track-rods. This hand steering gear can be locked in mid-position for normal operation. At the other end of the chassis each pair of wheels is mounted on a roller carriage which can be traversed along the main chassis longitudinal members by a double-action hydraulic cylinder through levers and a torque tube. From an extension of the operating cylinder lever this moving carriage assembly can be locked to the chassis with a pin. Hydraulically assisted steering is provided and in the event of a hydraulic failure the wheels may be steered by a bar inserted into a socket on the forward end of the steering levers. Brakes fitted to all wheels are spring actuated with hydraulic release and a screw-operated brake release gear enables all brakes to be released manually with a wheel brace if, in case of emergency, it is necessary to tow the transporter.

The electric motor, hydraulic pump, tank and control gear, are mounted at one end on the top decking of the chassis and the 24V "Nife" battery on the deck at the other end.

In the sequence of operations to move the vehicle forward the roller bogie is first set in its most forward position along the chassis. The brakes of the front end wheels are then released and the brakes on the rear wheels applied. On pressure fluid then being admitted to the propulsion ram, the transporter is moved forwards 16in, rolling on its front wheels and on the carriages of the locked rear wheels. For the next move, the sliding bogie is first retracted to its forward position with the front brakes applied and the sequence of operation is then repeated.

This travelling system has been designed to reduce shock loads to the minimum, as the machinery carried on the transporters will be both delicate and expensive.

[Reply Card No. E10653]

Launches and Trial Trips

BAMORA, cargo ship ; built at Govan by Harland and Wolff, Ltd. for the British India Steam Navigation Company, Ltd.; length between perpendiculars 395ft, breadth moulded 59ft, depth moulded to upper deck 32ft 6in, deadweight 7500 tons, speed 16 knots ; two continuous decks, four holds, five 3-ton electric cranes, four 10-ton derricks ; four 350kW diesel-driven alternators ; Harland and Wolff, two-stroke, single-acting, opposed piston oil engine, six cylinders 620mm bore by 1870mm combined stroke, 118 r.p.m. Launch, September 6.

INDUSTRIAL NEWS

De-nationalisation of Steel

The report and statement of accounts of the Iron and Steel Holding and Realisation Agency for the period October 1, 1959, to September 30, 1960, was published last week. It shows that during the year four companies were sold privately, reducing the direct holdings of the Agency in subsidiaries, including one company which is in voluntary liquidation, to eight. In terms of employment, of steel production and of sales of products it is estimated, the report says, that the companies which have ceased to be subsidiaries accounted for over six-sevenths of the Agency's "inheritance." Richard Thomas and Baldwins, Ltd., represented over three-quarters of the value of the companies which still remained subsidiaries of the Agency at September 30, 1960.

During the year under review, the report states, approval was given to proposals to accelerate and extend the construction of the integrated steel works at Newport, Monmouthshire, of Richard Thomas and Baldwins, Ltd., to include an increase in the steel ingot capacity from 1,000,000 tons to 1,400,000 tons per annum and in the cold reduced sheet capacity by an additional 235,000 tons a year. The Minister of Power has agreed to increase the maximum amount of his loan from £60,000,000 to £70,000,000, and it is now estimated, the report adds, that the final installations of the Newport scheme, as accelerated and extended, will cost approximately £119,000,000.

During the year the Agency has approved the installation of sinter plant by Skinningrove Iron Company, Ltd.

The liquidation of Normanby Iron Works Company, Ltd., has been virtually completed, the report states, apart from the disposal of the site, which is in process of being cleared.

Iron and Steel

The Iron and Steel Board announces that the month of November was the first month in which the weekly average steel production has exceeded 500,000 tons, The actual figure, 504,500 tons a week, was 7500 tons a week above the previous highest figure reached in October, and 46,000 tons a week, or 10 per cent above the figure for November, 1959. The production of pig iron in November, at a rate of 315,000 tons a week also exceeded the previous record level reached in October by 1185 tons a week, and was 37,700 tons a week, or 13 per cent higher than the figure for November, 1959.

The current rate of steel production is equivalent to 25·2 million ingot tons a year, the Board says, allowing for normal holidays and it is estimated that production during 1960 will amount to about 24,300,000 tons. The demand for steel for investment, the largest sector, is expected to continue at a high level into 1961, the Board says, while demand for steel for motor-car and other consumer goods may be less buoyant at least in the first part of the year. The demand for stock-building, which absorbed some 1,400,000 ingot tons of steel in the first nine months of 1960, is unlikely to be repeated, the Board suggests. Imports, which amounted to 1,300,000 ingot tons in the first nine months, are expected to fall very substantially.

Arrangements are in hand, the Board says, for the supply of raw materials needed to meet a steel production in 1961 which is expected to lie within the range of 24,000,000 to 25,000,000 tons on the basis of present trends. But if demand is stronger, further output above this range could be secured without creating the need for any significant imports of scrap and pig iron.

The results of the census taken at the end of September are now almost in their final form. They indicate, the Board says, that users' stocks of finished steel in total rose by a little over 200,000 tons in the third quarter, whilst the increase in the stocks of sheet amounted to 150,000 tons.

Transport

The Association of British Chambers of Commerce has published a report entitled "Transport for the Future," analysing the principles of its approach to a future transport structure for the nation. At the Association's annual general meeting in 1959, the conference affirmed its belief "... that a freely competitive transport system best serves the nation in its general economy and its commercial efficiency." The present structure is unbalanced, the new report says, because it is sharply divided into a public sector operating at a loss, and a private sector operating at a profit.

The report proposes that the British Transport Commission should be relieved of its responsibilities for, and financial interests in, road passenger transport, inland waterways, and the majority of its dock undertakings, and that it should be re-named the British Railways Commission.

The Association welcomed improvements represented by such services as the "Export Express," but felt that such quality should be aimed at for all traffic. The modernisation plan, the report says, even in its revised form, may take too long term a view of the case for current problems, and there should be more concentration on prospective short-term gains. High priority must be given to continuous braking systems together with automatic coupling, so that really fast freight trains become a reality. It is felt, the report adds, that in the past the Commission has given insufficient attention to the strategic location of railheads and the provision of alternative road services when closing branch lines. With regard to costs, the Association stresses that, because of their unwieldy structure, railways are in need of accurate forecasting to a very much greater degree than their competitors. Management incentive must be maintained, the report says, and a greater infusion of cost consciousness into the local manager is essential to support his commercial activity. The railways should be managed separately from other transport organisations, the report states, and their management should be through autonomous regions co-ordinated by a Railways Commission.

Each of the components of the Commission, the Railway Regions, London Transport and British Road Services, should bear its proper share of capital liability, the Association says, which it would have to cover from its revenue earnings. Where subsidies were considered necessary applications would be channelled through the Commission for approval by the Government.

The report proposes the inclusion of London Transport as a component in its present form, but feels that at some future date this might well embrace the London underground services only, leaving London road passenger services to be managed in some other way. British Road Services have been included as part of the British Railways Commission because it is felt that, in future, there are possibilities of greater co-ordination between it and British railways resulting from the streamlining of the railway system and the road conveyance of railway traffic over much wider areas.

The nation's inland waterways collectively should be supervised by a Central Waterways Advisory Authority, the Association states, and this Authority should take over all the existing B.T.C. waterways and dispose of them suitably according to their potential utilisation including those capable of profitable transport use.

Work Study

The introduction of work study into any industrial establishment invariably brings in its train a number of problems from the angles of both management and work-people. Although these problems may vary considerably between establishments there are certain common factors, and for this reason a recent D.S.I.R. publication, "The Human Implications of Work Study," will be read with interest by firms contemplating the introduction of work study. The book is based upon a factual case study at a medium-sized firm in the Midlands—under the pseudonym of Pakitt, Ltd.—and it was compiled by S. Dalziel and L. Klein of the Human Sciences Unit at Warren Springs Laboratory.

The book deals with the impact of work study at all levels and describes what happened during, and after, the introduction of work study by a firm of consultants. It is a study of change and people's reaction to it. Although this application of work study was not wholly successful, the book shows that subsequent analysis of the difficulties encountered revealed that their real cause was neither obvious nor technical—they were due to different expectations and basic assumptions of the various groups concerned. The same words and phrases, the book points out, held quite different meanings for different people. Analysis showed that the changes which were introduced involved a closer control of people's activities and they felt under constraint and pressure. Management and the consultants did not anticipate this closer control nor did they recognise it when it happened.

Whilst making it clear that it is impossible to draw up a series of "do's" and "dont's" for the introduction of work study, the report contains a number of useful recommendations which should make it valuable both to industry and for teaching purposes in management courses.

PERSONAL AND BUSINESS

Appointments

THE BERGIUS COMPANY, Ltd., has appointed Mr. T. Lewis, M.I.Mar.E., to its technical staff.

MR. J. P. V. WOOLLAM, M.I.Chem.E., has been appointed deputy chairman of Simon-Carves, Ltd.

MR. V. L. PINNOCK has been appointed to the board of directors of B. and F. Carter and Co., Ltd.

MR. I. S. WHITEMAN has been appointed to the board of directors of NCK-Rapier, Ltd. He continues as general manager.

MR. A. NADIN, general manager of Brayshaw Furnaces, Ltd., and Brayshaw Tools, Ltd., has been appointed a director of both companies.

A. REYROLLE AND CO., Ltd., announces that it has co-opted to the board Mr. W. Gray, M.I.E.E., A.M.I.Mech.E., chief engineer of the company.

MR. A. S. PUDNER, A.M.I.E.E., area engineer, West Indies, has been appointed to be an additional assistant engineer-in-chief of Cable and Wireless, Ltd.

MR. WILLIAM WILLETT has been appointed sales representative for David Rowen and Co., Ltd., and its subsidiary company, Rankin and Blackmore, Ltd.

MR. G. U. HOPTON, M.I.Chem.E., M.Inst.Gas.E., has been appointed the new director of the Gas Council's London Research Station at the Fulham Laboratories.

MR. JOHN B. CAPEY, managing director of Steele and Cowlishaw, Ltd., is to retire at the end of the year. He will be succeeded by Mr. J. A. Harley, at present deputy managing director.

MR. H. N. EDWARDS, chairman of the Railway Carriage and Wagon Building Association, has at his own request relinquished the position. Mr. D. J. C. Robertson has been elected to fill the vacancy.

MR. M. A. L. BANKS, MR. A. F. MCDONALD and MR. R. B. SOUTHALL have been appointed to the board of British Hydrocarbon Chemicals, Ltd., and Mr. C. E. Evans has been appointed managing director.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., has announced the following appointments : Mr. W. R. Brew, executive manager (engineering) ; Mr. F. L. Gladwin, executive manager (commercial) ; Mr. O. V. Metcalfe, executive manager (production) ; and Mr. R. C. Ray, sales manager.

W.G.I., Ltd. (West's Group of Industries), announces that Mr. M. S. Gaskill and Mr. S. J. F. Beale have been appointed directors of the company. Mr. Gaskill retains his appointment as technical director, West's Gas Improvement Company, Ltd., and Mr. Beale continues as managing director, the Derbyshire Silica Firebrick Company, Ltd.

DISTINGTON ENGINEERING COMPANY, Ltd., a subsidiary of The United Steel Companies, Ltd., announces the following appointments which will take effect from January 1 : Mr. A. G. Thorburn, machine shop manager, will become quality control engineer ; Commander M. G. Lyne, quality control engineer, will become chief planning engineer ; Mr. J. Lowe, assistant machine shop manager, will be appointed acting machine shop manager.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., has decided to put into effect, on January 1, a modified scheme of organisation involving a redistribution of responsibilities among the executive directors. By combining research and development and discontinuing economic planning, the number of functions has been reduced from eight to six. The functional directors will be as follows : commercial, Mr. W. D. Scott ; finance, Mr. P. T. Menzies ; Overseas, western hemisphere and Africa south of 15 deg. of north latitude, Mr. R. C. Todhunter, Europe, excluding U.S.S.R. and Eastern Europe, Dr. A. Caress, rest of the world, Dr. J. S. Gourlay; personnel, Mr. C. M. Wright; research and development, Dr. J. Ferguson ; technical, R. Beeching. The manufacturing divisions have been regrouped, and the number of groups reduced from six to five. The group directors will be as follows : group A (comprising alkali and general chemicals divisions), Dr. J. Ferguson ; group B (comprising dyestuffs, paints and pharmaceuticals divisions), Mr. G. K. Hampshire ; group C (comprising fibres, heavy organic chemicals and plastics divisions), Mr. C. Paine ; group D (comprising Billingham and Nobel divisions, Wilton Works and Severnside Works), Mr. R. A. Banks ; group E (comprising metals division), Dr. J. Taylor.

THE ELECTRICAL RESEARCH ASSOCIATION announces that Mr. L. Gosland has been appointed deputy director in addition to the position of research manager which he already holds. Mr. C. G. Garton and Mr. E. W. Golding have been appointed assistant directors of the Association. Mr. Garton will continue as head of the materials department, and Mr. Golding will continue as head of the rural electrification department, and also as overseas liaison officer.

Business Announcements

MR. PERCY E. WHEATLAND has retired from The General Electric Company, Ltd., after forty-seven years' service.

BROOK MOTORS, Ltd., announces that the new telephone number of its Leicester sales office are Leicester 50781/2/3.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., has announced the retirement of Mr. T. E. H. Birley, deputy overseas manager, after forty years service with the company.

G. A. HARVEY AND CO. (LONDON), Ltd., states that its sales department now operates from Villiers House, Strand, London, W.C.2 (telephone, Whitehall 9931/7).

THE ELECTRICAL RESEARCH ASSOCIATION announces that its offices at Dorking Road have been closed and that new offices have been opened at Cleeve Road, Leatherhead, Surrey (telephone, Leatherhead 4151).

GUEST KEEN IRON AND STEEL COMPANY, Ltd., East Moors, Cardiff, states that as from January 1, 1961, the title of the company will be changed to Guest Keen Iron and Steel Works (branch of G.K.N. Steel Company, Ltd.).

LOW MOOR FINE STEELS, Ltd., announces that Mr. R. Cox, works manager, and Mr. B. P. Yates, director of Low Moor Alloy Steelworks, Ltd., and Brayshaw Furnaces, Ltd., have been appointed additional directors.

OLDHAM AND SON, Ltd., has opened a new and larger depot at Norwood Road, Birmingham, to cover the services and sales requirements for motor-car and industrial electric batteries over twelve Midland counties and mid- and south Wales.

OPPERMAN GEARS (HOLDINGS), Ltd., announces the purchase of W. J. Mariner and Co., Ltd., Luton, Bedfordshire. Mr. E. R. Opperman is now the chairman of W. J. Mariner and Co., Ltd., and Mr. J. A. Mariner continues as managing director.

THE MINISTRY OF TRANSPORT states that its highways department has moved to new offices at St. Christopher House, Southwark Street, London, S.E.1. The London traffic management unit and London traffic division has also moved from Berkeley Square House to St. Christopher House.

THE GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, London, W.C.2, and A.B. ELECTROLUX OF SWEDEN, whose British subsidiary is Electrolux, Ltd., announce the conclusion of an agreement by which they will associate jointly in the development of the thermo-electric refrigerator.

STONE MARINE ENGINEERING COMPANY, Ltd., Woolwich Road, Charlton, S.E.7, states that it has taken over the sale of all yellow- and white-metal products previously handled by J. Stone and Co. (Propellers), Ltd. Mr. P. A. T. Burrows has been appointed sales representative for these products.

STOTHERT AND PITT, Ltd., Bath, announces that it has entered into an agreement with Ellicott Machine Corporation of Baltimore, U.S.A., for the manufacture, under licence in the United Kingdom, of dredgers and dredging machinery of Ellicott design. At the same time, Ellicott has announced that it will be represented in a sales capacity in the United Kingdom by John Blackwood Hodge and Co., Ltd.

RUBERY, OWEN AND CO., Ltd., P.O. Box 10, Darlaston, Wednesbury, Staffs, announces that an agreement has been concluded with a French manufacturer, Societe Parisienne de Material et Equipment, giving it selling rights for the Hallsworth automatic moulding system in France and French territories. Rubery-Owen has licensed Sopame to manufacture certain parts of the equipment under licence, but will export the Mk. 11 moulding machine to France.

CONSTRUCTORS JOHN BROWN, Ltd., Eastbourne Terrace, Paddington, London, W.2, announces that its automatic control division has been formed into a wholly owned subsidiary company known as Automatic Control Engineering, Ltd. Directors of the new subsidiary are : Mr. I. J. Crosthwaite, chairman ; Mr. H. D. Walker, M.I.Mech.E., Mr. R. Riley, M.I.Mech.E., Mr. H. H. Rosenbrock, M.I.E.E., and Mr. M. P. Atkinson. Mr. Riley will also hold the position of general manager and Mr. Atkinson that of chief engineer. The address of the company is Roxby Place, Seagrave Road, Fulham, S.W.6 (telephone, Fulham 7761).

Contracts

DAVY-ASHMORE, Ltd., announces that its subsidiary, Davy and United Engineering Company, Ltd., has received an order worth approximately £300,000 from the Broken Hill Proprietary Company, Ltd., Newcastle, New South Wales, for the design and supply of two 200-ton basic oxygen converter furnaces. The furnaces will be manufactured in the Stockton works of Ashmore, Benson, Pease and Co., Ltd.

FERRANTI, Ltd., has obtained a contract worth over £400,000 from the Electricity Commission of New South Wales, for the supply and installation of three 240MVA, 16·5/348kV, three-phase generator transformers. The contract was negotiated through Wilson Electric Transformer Company, Pty, Ltd., of Melbourne, who will undertake installation of the transformers. The units, which will be the largest with aluminium tanks built in the United Kingdom, are to be installed at Vales Point Power Station, 70 miles north of Sydney. Aluminium tanks will keep the weight of each unit down to 147 tons for transport purposes. Integral high-speed, on-load, tap-changing gear will also be provided for each unit, the first of which is scheduled for delivery about the end of 1961. The transformers, which will be off-loaded at Sydney, will be the largest ever to be imported by Australia and because of their size will present a number of delivery problems. A complete unit with cooling equipment will weigh 265 tons, of which the largest single section will be the core, windings, on-load gear and tank assembly, 29ft long by 12ft wide by 14ft high weighing 147 tons. This load will be the largest ever handled by Sydney Harbour's floating crane, which has a capacity of 150 tons. The crane will lift the unit out of the ship on to a specially constructed road-rail wagon. This wagon will go as far as Wyee and because of its width the N.S.W. Railways will have to close the return track and use single-line working. On arrival at Wyee, the 75ft-long wagon will have its rail bogies removed and replaced with pneumatic-tyred wheels. For the last 3 miles of the journey to the site the wagon will be towed by large diesel prime movers.

Miscellanea

NEW WAYS WITH RUBBER.—There is now available free of charge from the Department of Scientific and Industrial Research, Charles House, 5-11, Regent Street, London, S.W.1, an illustrated booklet surveying the newer kinds of rubber and describing their industrial applications ; the term " rubber " is used in a wide sense to include such substances as the highly abrasion-resistant polyurethanes. The booklet includes a table of general properties and a list of the relevant products showing which members of the Rubber and Plastics Research Association of Great Britain (which, as the Research Association of British Rubber Manufacturers, co-operated in its preparation) supply them.

SYMPOSIUM ON COMMUNICATIONS SATELLITES.—A one-day symposium on the use of the communications satellite has been organised by the British Interplanetary Society, and will be held in the Council Room of the Federation of British Industries, 21, Tothill Street, London, S.W.1, on May 12, 1961, from 10 a.m. to 5 p.m. Six papers will be presented. Subjects and authors arranged so far are : " Communications Satellite System Suitable for Commonwealth Telecommunications " (Dr. W. F. Hilton, Hawker-Siddeley Aviation, Ltd.) ; " The Synchronous Communication Satellite " (R. P. Haviland, G.E.C.) ; " Low-Cost Communications Satellites " (A. M. Peduzzi) ; " The Engineering and Economics of Satellite Communication Systems " (G. K. C. Pardoe, De Havilland Aircraft Company, Ltd.) ; and " Active Communications Satellites " (Dr. G. E. Mueller, Space Technology Laboratories).

Canberra Lake Project

By OUR AUSTRALIAN CORRESPONDENT

CANBERRA, Australia's national capital, was a preplanned city. The basic layout, superimposed on former sheep country, was the prize-winning design submitted by a Chicago architect, Walter Burley Griffin, in 1913. Griffin envisaged a city in two sections, on the northern and southern banks respectively of the Molonglo River, whose flood plain would be dammed to form a lake, unifying the overall design of the city (Fig. 1).

The Molonglo has a catchment of 727 square miles, within which are areas of serious erosion. The resulting siltation in the lower reaches has increased the effect of floods (Fig. 2) until intra-city traffic is being obstructed. As much of the catchment as lies within the Australian Capital Territory is being treated to a three-year programme of erosion control, now well advanced. In the large area of the catchment in New South Wales a similar programme is being arranged, and the siltation problem will be solved before the dam is completed in 1963.

The Molonglo flats are currently used for casual farming between floods, which reached a maximum recorded flow of 115,000 cusecs in 1925, and the dam is expected to stabilise the water level at 1825ft a.m.s.l. in all but the most severe droughts and floods, which are estimated to reach a peak flow of 200,000 cusecs, the design discharge for the dam, not more than once in 200 years.

The dam, whose cross section is shown in Fig. 5, is a mass concrete structure, 800ft long and some 65ft in height, with a 500ft long centre spillway. Five flood gates, each 100ft in length by 15·5ft effective height, are hinged at the upstream face and hydraulically actuated by four jacks per gate. Two of the gates will be automatically controlled through flood warning stations on the upper catchment, and for minor fluctuations in flow there are three automatically operated sluice gates in the lower section of the dam. Energy dissipation blocks are placed at the sluice gate exits on the downstream face of the wall and at the mid and end sections of the 75ft long apron. A crest road bridge 15ft above the stabilised water level will be supported on concrete piers at 110ft intervals. The lake formed will be 6·8 miles long with a maximum width of 4000ft, and a shore line of approximately 20 miles. The area will be 1740 acres and the volume 22,500 acre feet.

A 1 in 4000 hydraulic model was constructed and operated by the Commonwealth Department of Works (Fig. 3) as part of the investigations and as no serious obstacles in the general scheme were found, a larger model of the dam and a flume model of the spillway were later used for detailed flood flow simulation up to 300,000 cusecs.

Two major bridges will span the lake, one being the King's Avenue bridge now under construction. This is to be a duplex structure of

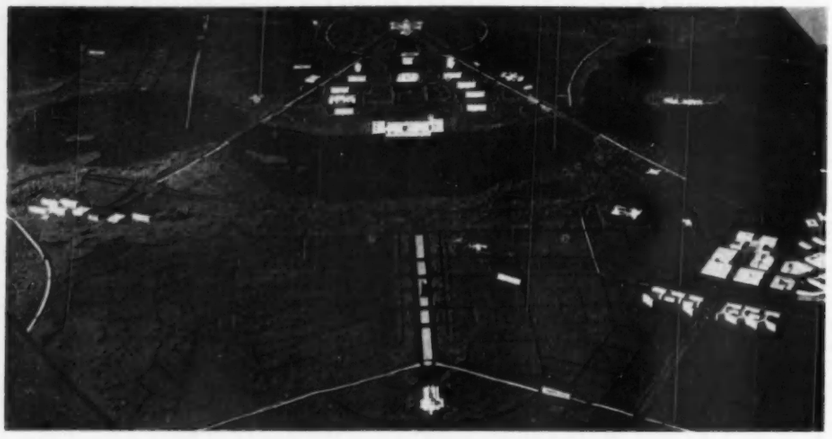
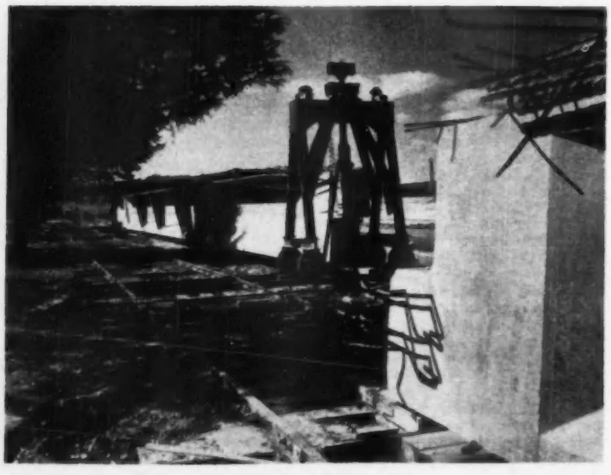


Fig. 1—Model of the central areas of Canberra showing the shape of the lake in relation to the basic city plan. Looking south to Capital Hill, Commonwealth Avenue bridge on right

Fig. 2—Aerial photograph of the Molonglo Plain under flood, looking across to Parliament House



Figs. 3 and 4. (Left)—The hydraulic model of the Canberra lake scheme. (Right)—Steel trusses in use to launch concrete beams beyond the Kings Avenue bridge abutments

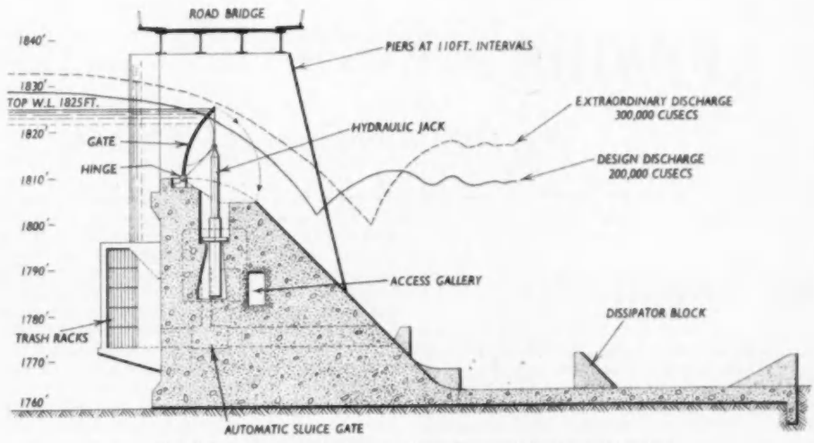


Fig. 5—Cross sectional diagram of the proposed Canberra lake dam

separated roadways, each carrying two lanes of traffic. The bridge is 950ft long between abutments with six intermediate piers at spacings varying between 93ft 6in and 154ft. Piers and abutments are supported on spread piles, and the piers are hollow precast units back filled with concrete. The deck is supported on four prestressed concrete beams, cast on site and launched beyond the abutments by welded steel launching trusses (Fig. 4). Bridge lighting is by fluorescent tubes mounted inside the hand-rail, but some overhead lighting will probably also be provided.

The second bridge, on Commonwealth Avenue, is still in the design stages but is expected to be generally similar to the King's Avenue structure. Each roadway will carry three tracks and it is likely that post-tensioned precast concrete box sections will be used for the deck-beams instead of prestressed units. The total length of the bridge will be 1020ft between abutments with four intermediate piers; centre clearance will be at least 22ft.

The National Capital Development Commission is providing overall direction for the scheme, due for completion in 1963. Dam design was by the Department of Works, with sluice gates designed by the Snowy Mountains Hydro-Electric Authority. The contract for the construction of the dam was let to A. E. Goodwin, Ltd., in conjunction with Rheinstahl Union of West Germany. Bridge design is by G. Maunsell and Partners, with Hornibrook, McKenzie, Clark Pty., Ltd., as contractors to the Department of Works.

Hydro-Electric Schemes in Kerala, India

FROM A CORRESPONDENT IN INDIA

Paringalkuthu Hydro-Electric Scheme

THE commissioning of the fourth generating set at Poringalkuthu Power Station in Kerala State marks the consummation of the second stage of this hydro-electric scheme. The first stage was completed when the power station was officially opened on May 15, 1957, with three water turbine generating sets. This Kerala installation is situated some 30 miles from Chalakudy in the northern part of the State. The water supply for the power station is obtained from a storage reservoir which has been formed by the erection of a masonry dam across the Chalakudy River with a catchment area of 391 square miles. Water from the storage reservoir is conveyed to a tunnel through an open channel. The intake structure, consisting of twin concrete wells, allows the water to flow into a concrete lined tunnel driven in rock for a length of 4029ft. At the lower end of the tunnel is a surge shaft 57ft 6in diameter and 111ft high. Two low-pressure pipelines 8ft 6in in diameter lead from the surge tank. From the low-pressure pipes the water enters the 52in diameter steel penstocks. Spherical valves of the self-closing automatic type are provided at the bottom of each penstock inside the power station building. Water from each of the penstocks flows to a vertical reaction Francis turbine with a gross head of 595ft. There are four turbines, each of 13,500 h.p., driving 8MW, 600 r.p.m. alternators. The power generated at Puringalkuthu is transmitted at 66kV to Chalakudy switching station and from there is fed into the Kerala State Grid. Later, the transmission voltage will be raised to 110kV. For this power station English Electric has supplied four vertical shaft 8M, 11kV, 600 r.p.m. alternators, four 10MVA, 11/66-110kV step-up generator transformers and six 1500MVA, 110kV, three-phase outdoor oil circuit breakers. In addition the auxiliary transformers, switchgear, control panels and a house generator set have been supplied by the same company.

The Panniar Hydro-Electric Scheme

THE Panniar Hydro-electric Project is a logical development in harnessing the waters of the Mudirapuzha River in Kerala State. It is an independent scheme, contemplating the construction of an upper and a lower reservoir on Panniar River, a tributary of the Mudirapuzha. The waters from the upper reservoir will be let down the river into the lower one, 18 miles downstream and the combined storage will be passed through a tunnel and thence through steel penstocks to the power-house, 850ft below, to generate 15,600kW at 100 per cent load factor. Both the reservoirs will enable a firm power draught of 300 cusecs for Panniar power-house. The upper dam at Anayirankal will be built into a catchment of 115 square miles at its junction with the Mudirapuzha. It will be 1000ft long and due to the rocky foundations on the left bank, a cement masonry section of 264ft long will be provided. The spillway, designed to discharge 13,100 cusecs, will be located in this section. The rockfill section will be 736ft. The top width of the dam at the rockfill portion will be 20ft and masonry portion 12ft. The full capacity of the reservoir will amount to 1800 million cubic feet.

The left bank masonry section with the spillway will have a longitudinal drainage culvert 2½ft by 2½ft with 6in diameter vertical risers to reduce pressure due to uplift. The spillway will have three vents of 19ft by 16ft each with radial gates over the crest. Positive cut-off will be provided from the masonry section to the portion in the river bed on the right flank where the rock begins to dip. From thence to the toe of the right bank hill, sheet pile cut-off with clay blanket of suitable thickness and width on upstream is proposed. Concrete key walls and R.C. core walls will also be provided where necessary.

Outlet arrangements through an earth dam presented serious engineering problems as the outer sides of the outlet conduits always form a weak joint. With the collaboration of the Central Water and Power Commission, it was decided to take the outlet through a tunnel driven through rock with suitable bell mouth, trash rack and control gates at the entrance. The tunnel will have a discharge capacity of 1100 cusecs. Up to the point where there will be sufficient cover for driving the tunnel R.C. conduit will be provided.

The Ponmudi reservoir in the lower reaches has a catchment of 110·5 square miles. Several alternatives were considered for the lower dam, and eventually a straight gravity masonry dam was chosen. The height of the dam is to be raised from the original figure of 150ft to 213ft for effecting total regulation of the run-off from the basin. The length of the dam will be 800ft with a bottom width of 145ft. The top will be 20ft wide. A central spillway of two vents 40ft by 25ft, each fitted with radial gates, will discharge about 36,000 cusecs flood. A drainage gallery 5ft wide and 7ft deep will be incorporated in the dam. Necessary protective works and energy dissipation arrangements at the toe are being constructed. A scour sluice 18ft by 8ft will also be built. The capacity of the Ponmudi reservoir will be 1820 million cubic feet.

Intake arrangements for leading the water into the tunnel will be built near the dam itself. A trash rack will screen the debris washed by floods and an inlet gate will regulate the water through the tunnel. The tunnel, which will be 9300ft long, will have a 72 square foot horse-shoe cross section. It will be a straight tunnel lined throughout and is designed to discharge 600 cusecs with a maximum velocity of 9ft per second. The surge shaft at the tunnel exit is 30ft in diameter and 10ft deep to absorb the surges. Two steel penstocks, 58in diameter, 2273ft long, discharging 300 cusecs, will drop the water at a maximum speed of 17ft per second from the surge shaft. From a length of 330ft at the beginning the penstocks will be embedded in concrete inside a tunnel. The balance of 1943ft will be exposed and held in position by concrete anchors. Each penstock will have a butterfly and air valve. The total weight of the pipeline is 720 tons.

The power-house will be built on the left bank of Mudirapuzha River slightly downstream and opposite the existing Sengulam power-house. A bridge across the river will connect both the power houses. It will be a reinforced concrete structure 150ft by 45ft. Two machines of 15,000kW will be installed. Power will be generated at 11kV and stepped up to 110kV for transmission purposes. The power that could be developed will be 15,600kW at full load with a generation of about 137 million units annually. The station will work with other stations in the Mudirapuzha group—Pallivasal, Sengulam and Neriamangalam. With the commissioning of Panniar scheme the flexibility of operation of the Kerala Electricity Grid will be very much increased. Though it is an independent scheme and regulation afforded by the two reservoirs at Anayirankal and Ponmudi in addition to operating the machines at Panniar power-house will help Neriamangalam station in the lower reaches with its tail waters to generate an additional continuous power of about 13,000kW, thus making the firm output from the scheme 28,600kW 100 per cent load factor.

The Panniar scheme will cost about Rs.3.35 crores. It is being constructed under the direction of Mr. A. O. Oomen, chief engineer, and Mr. K. V. Ranganathan, chief construction engineer of the Kerala Electricity Board, and is expected to be commissionined in 1962.

CONTINENTAL AFFAIRS

by Our Continental Editor

2000 b.h.p. Diesel Locomotive

THE diesel locomotive "V-160" recently put into service by the German Federal Railways is intended for mixed traffic on main and secondary lines. Developed by Fried. Krupp Maschinenfabriken, Essen, in collaboration with the Munich Central office of the Federal Railway, the locomotive has an axle arrangement B_0-B_0, with all four axles driven through cardan shafts and bevel gears from a single 2000 h.p. diesel engine, either a Maybach "MD870" or a Daimler-Benz "MB839AB." The transmission includes a double torque converter and two-speed gearbox equipped with a protective device against excessive revolutions per minute. All large components, such as the engine, cooling plant, air compressor, auxiliary diesel engine, lighting and starting dynamo, boiler and feed-water tank, can be separately removed and put back into place as required, except that in order to lift out the transmission, the cooling plant must first be dismantled. The table lists the principal data.

TABLE—*Principal Data of "V-160" Main Line Diesel Locomotive*

Gauge	1,435mm
Length over buffers	16,000mm
Total wheelbase	11,400mm
Distance between king-pins	8,600mm
Bogie wheelbase	2,800mm
Maximum height	4,250mm
Maximum width	3,050mm
Driving wheel diameter, new	1,000mm
Driving wheel diameter, worn	920mm
Minimum negotiable radius of curves	100m
Minimum negotiable radius of hump	200m
Total adhesive weight (full service weight)	75·2 tonnes
Service weight with two-thirds supplies	73·0 tonne
Axle load with full supplies	18·8 tonnes
Effective power (at 725 Torr, 30 deg. Cent. and 70 per cent humidity, maximum continuous speed of 1500 r.p.m.)	1900 h.p.
Maximum forward / reverse speed (upper range)	120 km.p.h
Maximum forward / reverse speed (lower range)	75 km.p.h.
Minimum continuous speed (upper range)	31 km.p.h.
Minimum continuous speed (lower range)	19·5 km.p.h.
Maximum starting tractive effort (upper gear range)	18·5 tonnes
Maximum tractive effort (lower gear range)	24·8 tonnes
Service supplies :	
Diesel fuel oil	3350 litres
Heating oil	850 litres
Boiler feed water	3000 litres
Sand	200 kg

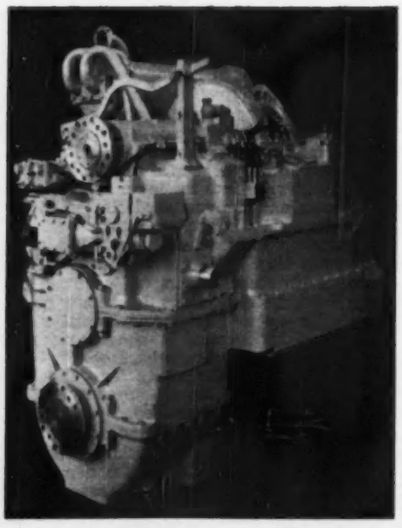
The fabricated, lightweight steel frame consists of two "U"-section longitudinal girders joined by diagonal and transverse beams, forming a bridge structure of great bending and buckling strength. Together with the fabricated superstructure built up from plates and channels to which it is welded, it forms an integral, torsionally rigid, load-bearing shell. The superstructure is divided into an engine and a boiler compartment, which again are subdivided by several soundproof partititions, and two driving cabs, one at each end.

The bogies have welded box girder frames, each comprising two longitudinal beams, one transverse king-pin girder in the centre and two transverse girders at the ends. From the longitudinal members of the bogie frame are suspended the adjusting hangers of the leaf springs, which are accessible from the outside, and the brake hangers. The wheelsets are supported at the overhanging axle ends in double self-aligning roller bearings, the axleboxes being mounted under the springs with additional rubber cushions. The tractive effort is transmitted by a standard king pin fitting into a deep bearing on the bogie, while the weight of the underframe and superstructure is carried on two pairs of helical springs, one on each side. In conjunction with two parallel-motion links attached respectively to the bogie frame and to the king-pin bracket, the arrangement allows elastic lateral deflection of 20mm. The king-pin distance is 8600mm, the bogie wheelbase 2800mm, and the length over buffers 16,000mm, which is moderate for an engine of this kind.

A continuous, quick-acting, multi-stage compressed air brake, model Knorr "KETm," is fitted, with combined control device model "KETmb" with pressure intensifier, triple valve, and "GPR" changeover device as well as auxiliary brake; each wheel is equipped with its own brake cylinder. At a speed of 50 to 60 km.p.h. a brake pressure regulator driven from one of the axles changes the braking from "high" to "low" and vice versa, while non-skid devices prevent skidding if brake shoes are applied too harshly. The hand brake in each driving cab acts upon two wheels of the bogie underneath. Compressed air for the brake is provided at 10kg per square centimetre by a 72 cubic metres per hour Westinghouse "403-P4/00" compressor, in addition to which there is a 76 cubic metres per hour compressor driven by an auxiliary diesel engine. Sanding is carried out by an electro-pneumatic device on the leading axle in either running direction. A "BBC" deadman's control and "Indusi" automatic train control are fitted.

Main Machinery.—Both the Maybach and the Daimler-Benz engines are four-stroke, high-speed, sixteen-cylinder vee-engines, the first supercharged and equipped for cooling the charging air, the second with simple charging and without charging air cooling. The engines are elastically mounted and the two makes are interchangeable. Silencers are arranged above the engine. Two main fuel tanks, each holding 1625 litres, are provided, as well as a 100-litre elevated service tank.

The drive from the diesel engine is taken to the hydraulic transmission by a cardan shaft with elastic clutch. The transmission is of the Voith "L218rs" design (illustrated) comprising two hydraulic torque converter cycles and one hydraulic clutch cycle, as well as the electro-pneumatic reversing gear, and the mechanical two-speed gear required for changing over from goods traffic to passenger service and vice versa.



Hydraulic transmission with two torque converter stages, electro-pneumatic reversing gear and hand-operated high/low mechanical gear. Top, input shaft : bottom, double-ended output shaft

The hydraulic transmission, which is situated in the centre of the locomotive, is directly supported on the frame at three points, viz. on two ball and socket bearings in front and one rubber cushion at the rear.

A power take-off at the input side drives the lighting and starting generator through a cardan shaft, while, from the far end of the generator, vee belts drive the two oil pumps which supply pressure oil for operating the servo-cylinders of the radiator louvres.

The output shaft is situated underneath the transmission, and to its fore- and aft-facing ends are connected two cardan shafts which transmit the drive to the axle gearboxes of the inner wheelsets, from where two further cardan shafts extend the drive to the axle gearboxes of the outer wheelsets. The torque supports of the axle gearboxes are elastically linked to the bogie frames.

Cooling water is circulated in turn through the diesel engine jackets and a by-pass cooler for the engine lubricating and cooling oil, and an oil cooler for the transmission oil, after which it passes through fan-cooled radiators fitted on both sides near roof level. A second by-pass circuit is provided in the case of the Maybach engine for cooling the charging air.

It is claimed that a practically constant cooling water temperature is maintained independently of the load, by servo-controlling the airflow through the top radiator louvres, while the bottom louvres on each side of the engine are set by hand in accordance with the seasonal temperature changes.

Controls.—The "V-160" engine has electro-pneumatic controls. Power control is effected by handwheel from each driving desk in fifteen notches with continuous rating and one starting notch. Both the driving machinery and the heating plant are maintained in operation fully automatically. Remote driving controls make possible the operation of push-pull as well as multi-engined trains.

Electrical equipment includes a 110V, 240Ah accummulator battery, the main lighting and starting dynamo, one auxiliary diesel generator set, the electric motors of the auxiliary services, the switchgear and controls in the driving cab.

Heating Plant.—An oil-fired boiler is installed capable of producing 750kg per hour of steam for heating purposes. The insulated storage tank for this boiler is located between it and the respective driving cab. Capable of holding 3000 litres, it also has the function of storing heat when the engine is standing idle in cold weather. For this purpose, the water in the tank is heated to about 70 deg. to 80 deg. Cent. by blowing steam through it. It is subsequently circulated intermittently through a heat exchanger and thereby keeps the engine cooling water at a temperature of 10 deg. to 20 deg. Cent. for up to ten hours even in outside temperatures of the order of −25 deg. Cent. If the permissible cooling water temperature is not maintained, a warning hooter is sounded. For the purpose of warming up the diesel engine prior to starting, the heat exchanger also incorporates a steam coil.

Electric power for operating the boiler while preheating the engine and the passenger coaches, as well as the compressed air required for the boiler and for charging up trains taken out of service, is provided economically by the 22 h.p. air-cooled auxiliary diesel generator and compressor set.

THE AMERICAN SCENE

by Our American Editor

Electronic Telephone Central Office

A CUSTOMER trial of the world's first electronic telephone central office was started at Morris, Illinois, last month by the Bell Telephone Laboratories and the Illinois Bell Telephone Company. Developed by the Bell Laboratories, it is the first system which performs electronically all the functions in the handling of telephone calls. Through the use of gas tubes, a vast memory system, and thousands of transistors and other solid-state devices, the "Electronic Central Office" permits the trial users at Morris to: (1) use home extension telephones as " intercoms," simply by dialling two digits ; (2) reach frequently called numbers by dialling only two digits instead of seven ; (3) have incoming calls routed to another telephone when the originally called line is engaged ; and (4) dial a code which causes all subsequent incoming calls to be automatically transferred to any other number. Other new services expected to be introduced after the trial is under way will permit many of the trial customers to allow a third party to be called into an existing telephone conversation, and to have an immediate connection to an engaged line as soon as the line becomes available.

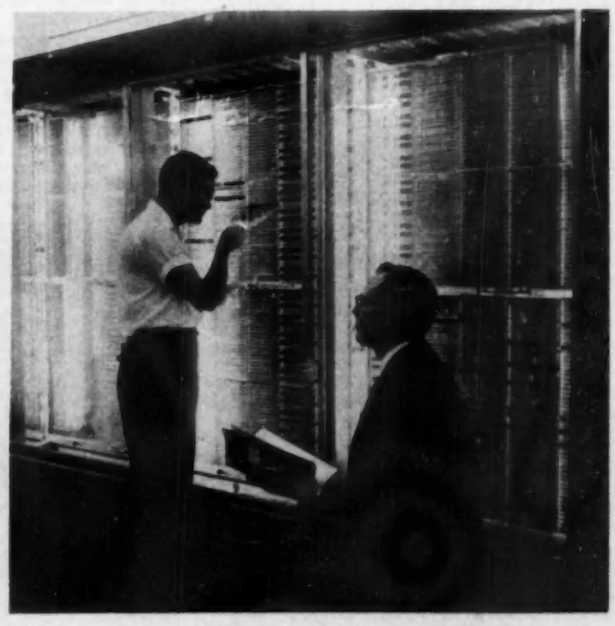
The E.C.O. machine works like this : The " eyes and ears " (scanner) checks the condition of every telephone line ten times a second, day and night. When a Morris customer picks up his telephone to make a call, the scanner detects the action and reports it to the " brain " (common control). The " note pad " (barrier grid store) shows that this is a new call, because its record shows that a tenth of a second ago the phone was in the " on-hook " position. The " note-pad " also reports that it has no record of anyone trying to reach this line, so the " brain " decides that the customer wants to dial. The E.C.O. machine sends a dial tone to the customer, letting him know that the system is ready to handle his call. At the same time, space is reserved in the barrier grid store for the digits to be dialled. The scanner now speeds up, looking at this customer's line 100 times a second so that it will not miss any of the dial pulses. Assume now that this customer has the special service known as " abbreviated dialling," which allows him to reach several of his frequently called numbers by dialling just two digits instead of seven. When he requested this service he gave the telephone company the directory number for each telephone he wanted to have represented by a two-digit code. This information was listed in the photographic memory. Now, the customer dials the two-digit code which represents his brother's telephone number. The E.C.O. first checks to see if this customer has abbreviated dialling service. It finds that he does, and it recognises the two-digit code as shorthand for his brother's directory number. The " brain " then commands the memory to report the complete directory number. Central control next sends a command to the switching network to set up a ringing circuit to the brother's telephone. It makes a point, too, of feeding the calling customer ringing tone, so that he will know that his brother's telephone is ringing. Someone at the brother's home picks up the telephone. The scanner detects this within a tenth of a second. The " brain " orders the switching network to connect a talking circuit and drop the ringing circuit.

A complex automatic telephone switching system, such as E.C.O., simulates the brain in the twin functions of " logic " and " memory." Early dial telephone systems had distributed memory and logic—in the relays that were used to connect customers together. In later dial systems memory and logic were provided more efficiently. Separate relay units were provided expressly for temporary memory functions, such as recording numbers as they are dialled, and other relays are used solely for logic operations. It is the philosophy of the E.C.O. system not simply to substitute electronic devices for relays, but rather to solve call-handling problems on a completely new basis. The solutions to these problems are found in " answers " stored in the photographic memory. The " answers " are found a thousand times faster than with older systems, and can be easily changed to meet varying needs of the telephone business.

In the search for a memory system having a tremendous capacity and almost instantaneous access to stored items, the Bell Laboratories decided on the idea of storing information on photographic plates. A cathode ray tube produces a small spot of light which can be positioned to read out stored information from the plate. For each position of the spot of light, sixty-seven different items of information can be read out. In the flying spot store 2,250,000 items of information, or " bits," are stored, and any item can be read in a few millionths of a second. All the 2,250,000 bits can be read in one-ninth of a second. The E.C.O. " note pad "—the barrier grid tube—is a special electron valve. It is somewhat like a television picture tube, except that the target is not a phosphor screen but a piece of mica. A beam of electrons is shot at the mica target, and where the beam strikes an electrical charge is placed. A charge (or lack of charge) in any particular place on the mica represents an item of information. The item can be read quickly and then erased, leaving the space ready for new information. The end result of this complex electronic " brain " is to direct the closing of switches to connect one telephone with another. The switches in the Morris E.C.O. are neon gas tubes. When a connection is made the tubes " fire," showing an orange light. Light from blue fluorescent lamps shining on the tubes ensures quick firing. Also, the neon tubes are carefully temperature-controlled to obtain reliable operation.

Information gained from the Morris trial will not only tell how the E.C.O. performs, but it will

Circuitry of the central control " brain " at the experimental E.C.O. in Morris, Illinois



Switching network at the Morris E.C.O. employing neon gas-filled tubes instead of conventional relays

THE AMERICAN SCENE *(Continued)*

also give an insight into which of the new service features telephone users prefer. The trial will also present an opportunity to study the kinds of maintenance activity and the number of people needed to operate and maintain the new exchanges. During the trial, the Morris E.C.O. will be operated jointly by Illinois Bell and the Bell Laboratories. In appearance, E.C.O. has little in common with present exchanges. The long, high racks of equipment and the noisy chatter of relays are gone. Instead, there are several rows of neat grey cabinets (as illustrated) filled with thousands of plug-in packages of electronic components. The switching network, made up of 23,000 tiny, neon-filled tubes, goes about its work quietly, with only a bright red glow to show which tubes are operating. One of the keys to the success of the E.C.O. is that it uses stored programme control to perform its job ; each action of the machine is determined by instructions stored in its memory.

The difference between stored programme control and present systems can be simply illustrated by the two different ways a student can solve a square root problem. One way is by a series of logical steps—pointing off two places, &c. The other way is by looking up the answer in a book of square root tables. Existing exchanges use the first method to work out the detailed logic of each telephone call, item by item. The E.C.O., on the other hand, solves many of its problems by " looking up the answer in the book." In this case the " book " is information —2,250,000 bits—stored on photographic plates in the machine memory, telling it what to do in any situation.

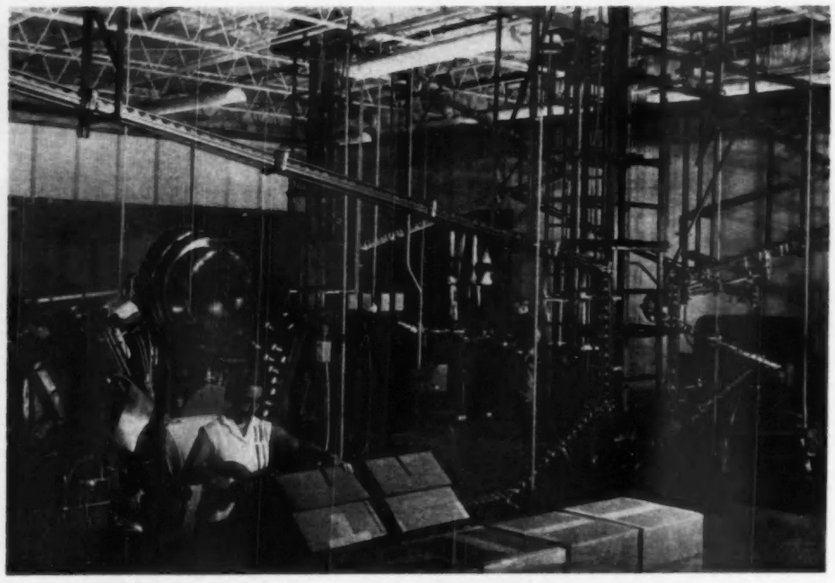
The E.C.O. performs its work with such speed that it has enough " spare " time to continually check its own circuits. When it discovers a fault, it locates and diagnoses the trouble and, in some cases, even makes the necessary corrections. If the fault cannot be corrected by the machine, it writes out in detail on a teletypewriter what the trouble is, adding the month, day, hour and minute of the malfunction. Then the repairs are made by a member of the E.C.O. staff. Although some of its basic theory has been known for many years, the E.C.O. became feasible only with the invention of the transistor and other semiconductor devices, and with the development of high-speed, high-capacity memory systems. To illustrate the importance of semiconductors to the system it has only to be noted that the Morris unit uses some 12,000 transistors and 105,000 diodes. Although the Morris E.C.O. is an experimental version, engineers are already at work on a production model, suitable for volume manufacture by the Western Electric Company. Many components in the production model will differ from those used at Morris, but the over-all philosophy of the two systems will be similar. The first production model will be operating by 1965, and from that time on E.C.O. will gradually be introduced into the Bell System to meet the needs of telephone growth and to replace worn-out central offices.

Deep-Drawn Aluminium Cans

A fully mechanised process for manufacturing drawn aluminium cans and a new easy-opening aluminium top have been developed by the Central States Can Corporation, of Massillon, Ohio, in conjunction with the E. W. Bliss Company and the Kaiser Aluminum and Chemical Corporation. The easy-opening lid system embodies a tab which is pulled to remove the lower seam so that the top can be easily removed. The lid itself has a deep, countersunk shape so that it may be placed back on the can, as a snug-fitting plug. The new opening principle is adaptable to round aluminium cans and the lid also may be used on composite cans which have aluminium tops and bodies of other materials. The tear strip is constructed so that there are no sharp edges remaining on the lid, so that the danger of cutting fingers is eliminated.

The Central States can manufacturing line has been designed to produce cans in three basic sizes : 2½in in diameter by 1½in in height ; 2½in in diameter by 2½in in height, and 3 7/16in in diameter by 1 13/16in in height. The can fabricating equipment was manufactured and installed by Bliss and is composed of three basic units. During the first stage, coated aluminium coil is blanked and the initial draw—up to half the diameter of the final can—is made. The draw for the 3 7/16in by 1 13/16in can is completed during this stage. For cans of greater height, the second draw is completed on an automatic re-draw press. Trimming and flanging operations comprise the third stage, with the completed cans then being conveyed to packing operations. The entire can line is completely automatic, with overhead conveyors transporting material through all stages. One operator and a packer comprise the crew for the process, which produces from 200 to 240 cans per minute. The covers for the can are produced conventionally and normal double seaming operations are utilised for closing.

The firm claims many advantages for the new aluminium can. The empty can weighs approximately only one-third as much as similar tinplate containers. The filled aluminium cans are 8 to 40 per cent lighter than filled tinplate or glass containers having the same volume, depending on product density. Due to the non-corrosive nature of aluminium, the cans may be stored for indefinite periods without danger of rust. Because the can is drawn, dangers of side and bottom seam leakage are eliminated. The new can also has excellent nesting characteristics, with a recess in the lid fitting the bottom of the can above it, making possible convenient stacking. Kaiser Aluminum coated coiled can stock is used in fabricating the containers and is supplied in gauges ranging from 0·006in to 0·016in.



Overall view of the aluminium can manufacturing line at Massillon, Ohio, with three presses and automatic conveying equipment

The easy-opening lid design of the new can employs a tab which is pulled to remove the lower seam of the lid

Powerful Linear Accelerator for Radiographic Inspection

An extremely powerful X-ray machine specifically designed for high-speed radiography in the metals industry will be installed at the Milwaukee works of the A. O. Smith Corporation next spring. The 8 MeV linear accelerator now is being built for the firm by the High Voltage Engineering Corporation, of Burlington, Massachusetts. The linear accelerator, or " Linac," is designed to inspect steel thicknesses of more than a foot and to provide photographic proof of the soundness of such metal structures as core barrels for nuclear reactors and high pressure vessels for the petrochemical industry.

The " Linac " produces its X-rays by " firing " high-energy electrons in a straight line down an evacuated tube. The electrons from the " Linac " move down the tube, impelled by travelling radio-frequency waves. These " radar " pulses accelerate the electrons until they approach the speed of light. At the end of the tube, the electrons strike a tungsten target and produce penetrating X-rays which are beamed upon the material to be examined. The operating head of the A. O. Smith machine will be 11ft long and 30in in diameter, with a 12in radiation aperture. Using 8 MeV, the " Linac " will produce 6000 roentgens per minute. While some other types of equipment employ higher voltages, they do not produce X-rays of such high intensity. The new machine will provide a choice of focal spot sizes of 1mm and 5mm. The respective outputs are 1500 and 6000 roentgens per minute, making possible the radiographic examination of very thick metals with both speed and clarity. For example, at full power and at a distance of 9ft, the 5mm focal spot source will X-ray an 11in thickness of steel in about one minute, or 16in of steel in about eighteen minutes. The 1mm focal spot source provides even greater clarity or resolution. It will radiograph 8in of steel in about one minute, or 14in of steel in about thirty minutes.

BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

CRANES

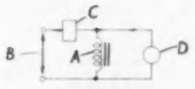
855,577. July 17, 1959.—Improvements in or Relating to Portable Cranes, Steel Construction and Engineering Company (Notts), Ltd., Phoenix Street, Sutton-in-Ashfield, Nottinghamshire. (*Inventor : Frederick Ralph Savory.*)

This invention provides a crane for use with a tractor having a hydraulic rear-lift and a power-take-off. The portable crane comprises a base with provision at its front end for three-point connection to a tractor with a hydraulic rear-lift and with support wheels at its rear end. A jib is hinged transversely at its foot to the upper part of the base and is raised by a jib-erecting mechanism power-operated by the hydraulic or mechanical services available on the tractor. A winch in the base is connected to the power-take-off of the tractor to operate the hoist rope. Preferably, the jib is hinged at the front of the base, to lie above the tractor during transport, and supported towards the front by a trestle mounted on the tractor. The jib-erecting mechanism may comprise a structure extending up from the base. When the tractor is fitted with ancillary equipment operable by an additional hydraulic ram, for example a front-mounted bucket with a pair of hydraulic lifting rams, the jib-erecting mechanism may simply comprise a mechanical linkage between the jib and the rams of the ancillary equipment. Alternative designs of the crane are described and illustrated by drawings in the specification.—*December* 7, 1960.

ELECTRICAL ENGINEERING

855,566. August 18, 1956.—Electrical Frequency Meters, Ferranti, Ltd., Hollinwood, Lancs. (*Inventors : William Gregson and William Frederick Sydney Turner.*)

An object of this invention is to provide a frequency meter which does not employ thermionic devices, and in which the frequency is displayed on a standard kind of moving-coil instrument. The diagram illustrates



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the principle of the invention. An inductor *A* having a saturable core is arranged to be energised by an alternating voltage *B* applied to the indicator in series with an impedance *C*. The voltage has a variable frequency, which is to be measured, and an amplitude such as to carry the core to complete saturation during each half cycle. Assuming that saturation is in fact complete for each voltage swing, it will be appreciated from first principles that the voltage drop across the inductor remains independent of variations of the amplitude of the voltage and of its waveform and is dependent solely on the frequency variations, this dependence being linear. The reading of an ordinary moving-coil instrument *D*, of suitable range, connected across the inductor can thus be made to indicate on its natural scale, suitably calibrated, the frequency of the voltage. In practice, the assumption that the core saturates completely at each half cycle is not justifiable and modified forms of the invention are illustrated in the specification, in which full-wave rectifiers provide voltages across resistors in the meter circuit in such a sense that the effect of amplitude variations in the input being measured is cancelled.—*December* 7, 1960.

ELECTRIC TRACTION

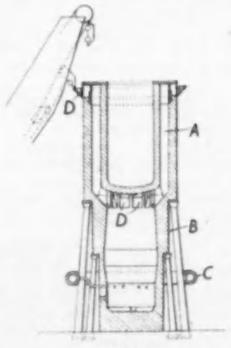
855,604. August 15, 1957.—Circuit Arrangements for Series-Wound Motors, Maschinenfabrik Oerlikon, Zürich-Oerlikon, Switzerland.

This invention relates to a series-wound motor operated with a ripple current, more particularly for driving rail motor coaches. The disadvantage of known expedients for improving commutation in these conditions is that losses in a parallel resistor are considerable, that a choke increases both weight and cost, and that the wave shape of the primary rectifier current is adversely affected. Moreover, considerable difficulties in commutation remain. According to the invention, a substantially ohmic impedance is shunted across at least the series-connected exciting and interpole windings. This permits a voltage to be induced in the short-circuited windings of the armature by the compole field, which will exactly balance the commutation voltage and the voltage induced in the armature by the field windings and thus considerably improve commutation. It has been found that harmonics due to saturation and slotting also have no adverse effect on commutation if this arrangement is used. Moreover, the armature current need not be much smoothed and a fairly small choke will be sufficient and may in given circumstances even be wholly omitted. Finally, owing to the less pronounced smoothing of the armature current the working conditions of the rectifier are better. In order to achieve improved commutation within as large a speed range as possible it is preferred to make the shunted resistance adjustably variable. It is also an advantage if the impedance is composed of an ohmic resistor and a capacitor connected in parallel or in series therewith. If a smoothing choke is provided, it may be desirable for the shunted impedance to bridge the series connected exciting winding, compole winding, and choke.—*December* 7, 1960.

FURNACES

855,532. July 29, 1959.—Low-Load Blast-Furnace for Iron Smelting, Prom Vajragupta, 80 Tong Loh Lane, Pra Kanong, and Phaothep Chotinuchit, 104, Samsen Nai, Dusit, both in Bangkok, Thailand.

The invention relates to furnaces for iron smelting, and provides a process and a furnace for continuous smelting whereby the load on the solid materials of the charge at the bottom of the furnace can be reduced in order to enable low-grade ores and inferior fuels to be used. In the embodiment of the invention illustrated, the furnace comprises an upper zone formed by a substantially vertical annular space *A* between two concentric shafts or cylindrical walls, superimposed upon a lower zone formed by a cylindrical wall *B* with tuyeres supplied from a bustle pipe *C*. In order to prevent the materials forming the furnace charge in the upper zone or space *A* from resting upon the materials in the lower zone, the bottom of the space is formed with



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inclined ports *D* opening inwards and downwards at an angle of about 30 deg. to 45 deg. to the horizontal. These ports lead down into the top of the lower shaft. This furnace can therefore be regarded as a blast-furnace having its upper part modified by dispensing with the usual upper zone for preliminary heating and reduction, and substituting an annular space *A* of volume approximately equal to that of the upper zone, but having the materials it contains supported at the bottom and not resting on those in the lower zone. Skip and hoist mechanism of normal design is employed for charging the furnace. The skips, on reaching the top of the inclined rails, discharge the raw materials and fuel for smelting into a hopper *D* of conical shape which is rotatable around the furnace. The mixed materials are deposited in a series of piles upon the sloping bottom of the hopper and against a concentric vertical door or fence. After each revolution of the hopper, the door is lifted to allow the materials to slide down against an inner door controlling their descent into the annular space. The two doors are opened alternately for feeding the charge into the furnace, while preventing leakage of gas. The annular space being comparatively narrow, the segregation of fine and coarse materials should not be as great as in the ordinary blast-furnace, and for the same reason the upward flow of gas should be fairly uniform, resulting in a more effective pre-reduction of the furnace charge. The ports connecting the upper zone to the lower part of the furnace provide for a smooth and uniform descent of the preheated and partially reduced charge into the lower zone. It will be seen that, except for the upper part of the furnace which is modified, this low-load blast-furnace retains all the other features of an ordinary blast-furnace.—*December* 7, 1960

RAILWAY SIGNALLING

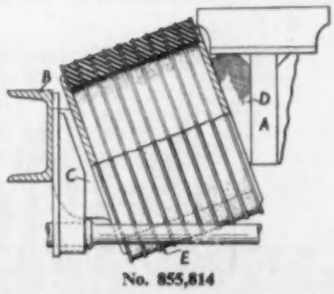
855,549. May 27, 1957.—Railway Track-Circuits, Compteurs et Moteurs Aster, 4, Rue du Général Foy, Paris (Seine), France. (*Inventor : Jean Cheronnet.*)

This invention relates to a form of railway track circuiting comprising generating and receiving devices operating on a common frequency, and at each end of the track circuit a parallel resonant circuit or "wave trap" device adjusted to the same frequency. These oscillating circuits disposed at the ends of successive track circuits could also be designated "separating circuits." Another feature of the invention is that each oscillating circuit is formed by a capacitor and a substantially non-resistive conductor connected between the two rails. When the short-circuiting connection, or bar, is perpendicular to the axis of the track, and the tuning capacitors are on each side of this connection, a definite separation of the two track circuits is obtained. However, a further feature of the invention is that the short circuit connection may be inclined relative to the axis of the track, when the passage of an axle over this circuit produces a shunting effect which varies continuously without any interruption. Various arrangements are illustrated in the specification, and reference is made to the possibility of using the tuning effect of an axle passing over such a circuit to detune and block an oscillator, this blocking forming a signal which may be used for certain purposes.—*December* 7, 1960.

RAILWAY VEHICLES

855,814. September 25, 1958.—Pneumatic and Spring Suspensions for Railway Vehicles, Metalastik, Ltd., Evington Valley Road, Leicester. (*Inventor : Archie John Hirst.*)

This invention relates to combined pneumatic and spring suspensions, in particular, although not exclusively, for railway vehicles. A solely pneumatic suspension for a railway vehicle has certain disadvantages, one of which is that the volume of the pneumatic cushioning is excessive. Another disadvantage is that if the usual compressed air system provided for brake actuation is used for supplying compressed air for the pneumatic suspension there is no air supply and therefore no resilient support for the vehicle when the compressed air system is not working. By providing a combined pneumatic and spring suspension, these disadvantages may be reduced or overcome. Three practical applications of the invention are described, by way of example only, the first with reference to the drawing. The



No. 855,814

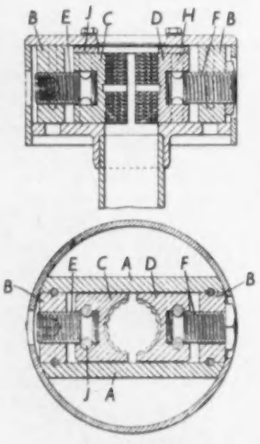
bolster *A* is supported from the frame of the vehicle and in turn supports the body in any convenient manner. The bolster extends parallel to, and between, a pair of transoms, one of which is indicated at *B*. Between a wedge *C* carried by the transom and a corresponding member *D* carried by the bolster there is a hollow block of rubber-like material, generally indicated by *E*. A pair of blocks are arranged opposite each other at each end of the bolster. The block *E* comprises a number of rings of rubber with metal interleaves between each pair of rings, the rings and the interleaves being bonded together. The rings at the end are secured to end plates engaging the wedges *C*, *D*, and closing the ends of the hollow block so that there is formed a sealed air space within. This space is connected

with a supply of compressed air and means are provided for regulating the supply of air and its escape. It is preferred that the body, or the bolster, is connected to one element of a valve, the other element of which is carried by the frame so that with variation in loading (and consequent adjustment in the height of the bolster) the valve is operated to permit compressed air to be supplied to the air space or escape. The result is that the bolster, and hence the body of the vehicle, is maintained at a predetermined height relatively to the vehicle frame. An advantage of the arrangement referred to is that the block is stable under all operating conditions without the necessity of providing a stabilising intermediate plate and the block is held so that the rubber interleaves are maintained, under all operating conditions, substantially parallel to one another.—*December* 7, 1960.

ROCK DRILLING EQUIPMENT

855,514. May 10, 1957.—CHUCKS FOR DRILLING, English Drilling Equipment Company, Ltd., Bilbao House, 36-38, New Broad Street, London, E.C.2., and Frank Walmsley, 9, Ennismore Gardens, East Molesey, Surrey.

In earth and rock boring equipment the drill rod chuck is secured [to a quill tube to which a rotary and drill feed action is given. In known constructions of chucks, the jaws are usually screw operated and slackening of the screw does not withdraw the jaws so that it is frequently necessary to strike the drill rod to free it from the jaws. An object of this invention is to provide a chuck which obviates rechucking difficulties, and facilitates withdrawal, adjustment or centring of the rod. As shown in the drawings the chuck body has two spaced members *A* which are bridged at their ends by cross members *B*. The cross members also space apart a cover and baseplate, the baseplate having a central bored spigot threaded for attachment of the quill tube of the drilling apparatus. Slidable on the baseplate are a pair of chuck jaws *C* and *D*, the inner ends of which are shaped and serrated in the usual manner for gripping the drill rod. The chuck jaws are advanced and retracted by threaded members *E*, *F*. The screw *E* has at is end a hole of square or hexagonal shape for engagement by a key which can be passed through an aperture in the chuck body to rotate the member and advance or retract the jaw *C*.



No. 855,514

The other member *F* has a slot in its outer end for its operation by a screw and it also has a lock-nut on its outer end. When inserting a drill rod it can be initially centred in the chuck between the jaws by rotation of both threaded members, after which the jaw *D* is locked in position by the lock-nut. Subsequent rechucking operations of the rod after raising of the drill head is simply achieved by retraction and advancement of the jaw *C* alone, this operation at the same time automatically centring the drill rod in the chuck. In order to release the drill rod from the serrations of the fixed jaw during a rechucking operation release means are provided in the form of a plate *H* on top of the jaws and fixed to the movable jaw *C* by an extension of the pins *J* holding the threaded member *E* in the recess at the end of the jaw. Upon retraction of the movable jaw to release the rod, the plate *H* slides over the fixed jaw *D* and moves the rod away from serrations. *December* 7, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Fri., Dec. 30.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, "Development of Electrical Equipment for Machine Tools," J. N. Leah, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Jan. 4.—RADAR GROUP : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Automatic Techniques in Civil Air Line Communications Systems," W. E. Brunt, 6.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., Jan. 10.—NORTHERN REGION : Grand Hall, Sheffield, Discussion on "The Problem of Grit Emission," 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Jan. 2.—BIRMINGHAM CENTRE : Bennett Hall, Y.M.C.A., Snow Hill, Birmingham, Display of Lighting Fittings, 6 p.m.
Thurs., Jan. 5.—NOTTINGHAM CENTRE : Electricity Centre, Carrington Street, Nottingham, "Light Effect on Dyes," W. L. Lead, 6 p.m.
Mon., Jan. 9.—SHEFFIELD CENTRE : Grand Hotel, Sheffield, "Recent Developments on the Continent in Exterior Lighting," A. G. Penny, 6.30 p.m.

INSTITUTE OF METALS

Tues., Jan. 3.—OXFORD LOCAL SECTION : Cadena Café, Cornmarket Street, Oxford, "Meteorites," H. J. Axon, 7.15 p.m.
Wed., Jan. 4.—LEEDS METALLURGICAL SOCIETY : Institute of Technology, Bradford, "Some Recent Developments in the Welding of Metals," E. N. Gregory, 6.30 p.m.
Thurs., Jan. 5.—LONDON LOCAL SECTION : 17, Belgrave Square, London, S.W.1, "Metallurgy in Electronics," J. E. Hughes, 6.30 p.m. ★ BIRMINGHAM LOCAL SECTION : College of Technology, Gosta Green, Birmingham, "Vacuum Technology" T. Thorley, 6.30 p.m.

INSTITUTE OF PETROLEUM

Wed., Jan. 4.—61, New Cavendish Street, London, W.1, "Pre-Flame Reactions in Diesel Engines, Part V—A Study of Temperature, Pressure and Ignition Delay," F. H. Garner, Frank Morton and J. B. Saunby, 5.30 p.m.

INSTITUTE OF PLANT ENGINEERS

Tues., Jan. 3.—PETERBOROUGH BRANCH : White Lion Hotel, Church Street, Peterborough, "Future Railway Development in Peterborough and District," 7.30 p.m.
Wed., Jan. 4.—EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, "Heating," A. A. Kidd, 7 p.m. ★ LEICESTER BRANCH : Midland Hotel, Leicester, "The River Dove Water Scheme," H. H. Wallhouse, 7.30 p.m. ★ SOUTHERN BRANCH : Polygon Hotel, Southampton, Members' Discussion, "My Job," 7.30 p.m.

INSTITUTE OF REFRIGERATION

Thurs., Jan. 5.—Institute of Marine Engineers, Memorial Building, 76, Mark Lane, London, E.C.3, "The Use of Two-Stage Freezing Procedures for Eviscerated Chicken," R. Gane and D. H. Shrimpton, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Jan. 3.—WESTERN CENTRE : Royal Hotel, Bristol, "Air Brakes for Commercial Road Vehicles," W. A. Kirk, 7 p.m.
Thurs., Jan. 5.—SOUTH WESTERN GROUP : Exeter City Fire Brigade, Exeter, "Servicing of Electrical Equipment," J. H. Stoneman, 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Jan. 2.—SOUTH MIDLAND CENTRE : James Watt Memorial Institute, Birmingham, Discussion on "Broadening University Courses," opened by H. E. M. Barlow, 6.30 p.m.
Tues., Jan. 3.—NORTH MIDLAND CENTRE : Leeds and County Conservative Club, South Parade, Leeds, 1, "Water-Turbine-Driven Induction Motors," C. L. C. Allan, 6.30 p.m.
Wed., Jan. 4.—TEES-SIDE SUB-CENTRE : Cleveland Scientific and Technical Institution, Middlesbrough, "The Fylingdales Early Warning Station," D. R. Evans, 6.30 p.m. ★ SHEFFIELD SUB-CENTRE : City Hall, Sheffield, "Colour Television," R. Feinberg, 3 p.m. ★ SOUTHERN CENTRE : The University Southampton, "The Planning and Economics of Telecommunication Plant," C. J. Stubbington, 7 p.m.
Thurs., Jan. 5.—ORDINARY MEETING : Savoy Place, London, W.C.2, Third Hunter Memorial Lecture, "The Application of Electronics to the Electricity Supply Industry," J. S. Forrest, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Tues., Jan. 3.—COVENTRY A.D. CENTRE : Grosvenor Room, Hotel Leofric, Coventry, "Recent Knowledge of Combustion," J. S. Clarke, 7.15 p.m.
Thurs., Jan. 5.—INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, "The Reliability of Mechanical Engineering Parts of Data Processing Equipment," 6 p.m. ★ EASTERN BRANCH : Hoffman's Social Hall, Chelmsford, "The Investigation of Radio Sources at Jodrell Bank," H. P. Palmer, 7.30 p.m. ★ EAST MIDLANDS BRANCH : Room 104, College of Technology and Commerce, Leicester, "The Vibration of Vertical Milling Machines under Test and Working Conditions," S. A. Tobias, 7.15 p.m. ★ WESTERN A.D. CENTRE : Royal Hotel, Bristol, Informal meeting, 6.45 p.m.
Fri., Jan. 6.—NORTH EASTERN BRANCH : Neville Hall, Westgate Road, Newcastle upon Tyne, Chairman's Address, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Jan. 9.—SHEFFIELD GRADUATE SECTION : B.I.S.R.A. Lecture Theatre, Hoyle Street, Sheffield, 3, "Grinding Wheels and their Application," C. Perrett, 6.30 p.m.

INSTITUTION OF PUBLIC HEALTH ENGINEERS

Mon., Jan. 2.—Caxton Hall, London, S.W.1, Discussion on "The Use of Light Alloys on Sewage and Water Works," introduced by H. Thatcher, 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Jan. 3.—NORTHERN COUNTIES STUDENTS' AND GRADUATES, BRANCH : Cleveland Scientific and Technical Institution, Middlesbrough, "Design of Welded Plate Girders," O. A. Kerensky, 6.30 p.m. ★ NORTHERN IRELAND BRANCH : Civil Engineering Department, David Keir Building, Queen's University, Belfast, Lecture and Film on "Piling," C. H. Bunclark, 6.30 p.m.
Wed., Jan. 4.—NORTHERN COUNTIES BRANCH : Neville Hall, Newcastle upon Tyne, "Value for Money in Building," E. S. Benson, 6.30 p.m.
Fri., Jan. 6.—GRADUATES' AND STUDENTS' SECTION : Engineering Centre, Stephenson Place, Birmingham, "Precast Concrete Frame Construction," B. E. Griffin, 6.30 p.m. ★ WESTERN COUNTIES BRANCH : Small Lecture Theatre, University Engineering Laboratories, University Walk, Bristol, 8, "Lift-Slab Design and Construction," F. R. Benson, 6 p.m.

INSTITUTION OF WELDING

Thurs., Jan. 5.—54, Princes Gate, Exhibition Road, London, S.W.7, Second Christmas Lecture to Young Children, "Sticking Things Together," J. G. Ball, 11 a.m.

JUNIOR INSTITUTION OF ENGINEERS

Fri., Dec. 30.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Films, "Yorkshire Transformer," "One for the Road," "Giant Load," and "Power Plant by Road to Site," 7 p.m.
Wed., Jan. 4.—MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Engineering in Chemical Works," E. R. Brazier, 7 p.m.

NEWCOMEN SOCIETY

Wed., Jan. 4.—Science Museum, London, S.W.7, "Joshua Gilpin, an American Manufacturer in England and Wales : Part II. 1811-14," Harold B. Hancock and Norman B. Wilkinson, 5.30 p.m.

PLASTICS INSTITUTE

Mon., Jan. 2.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Young People's Lecture, "Plastics and Textiles," H. A. Thomas, 2.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Jan. 3.—MIDLAND COUNTIES BRANCH : Birmingham and Midland Institute, Paradise Street, Birmingham, "Reinforced Concrete Construction in the Coal Industry," C. A. C. Davies, 6 p.m.
Fri., Jan. 6.—WEST OF ENGLAND BRANCH : University Engineering Laboratories, University Walk, Bristol, 8, Joint meeting with the Western Counties Branch of the Institution of Structural Engineers, "Lift Slab Design and Construction," F. R. Benson, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., Jan. 3.—ASTRONAUTICS AND GUIDED FLIGHT SECTION : Lecture Theatre, 4, Hamilton Place, London, W.1, "Planning of Missile Acceptance Trials," J. F. W. Mercer and A. R. Cawthorne, 6 p.m.
Thurs., Jan. 5.—Young People's Lecture : Lecture Theatre, 4, Hamilton Place, London, W.1, "Gyroscope and Pendulum —the Modern Travel Agents," R. J. Lees, 3 p.m.

ROYAL INSTITUTION

Thurs and Sat., Dec. 29 *and* 31.—21, Albemarle Street, London, W.1, Course of six lectures, "Seeing the Very Small," No. 1—"The Microscopical World," and No. 2—"The Eye and the Simple Lens," V. E. Cosslett, 3 p.m.
Tues., Jan. 3.—21, Albemarle Street, London, W.1, "Seeing the Very Small—No. 3. The Compound Microscope and its Limitations," V. E. Cosslett, 3 p.m.
Thurs., Jan. 5.—21, Albemarle Street, London, W.1, "Seeing the Very Small—No. 4. The Electron Microscope," V. E. Cosslett, 3 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Jan. 2.—ORDINARY GENERAL MEETING : 12, Great George Street, Parliament Square, London, S.W.1, "Fire Precautions in Buildings," F. W Delve, 5.45 p.m.

ROYAL INSTITUTION OF NAVAL ARCHITECTS

Thurs., Jan. 5.—10, Upper Belgrave Street, London, S.W.1, Third Amos Ayre Lecture, A. Hunter, 4.45 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Jan. 4.—CORROSION GROUP : Cathodic Protection Panel : 14, Belgrave Square, London, S.W.1, Discussion on "Galvanic Anodes," 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Fri., Jan. 6.—FAWLEY SECTION : Administration Building, Esso Refinery, Fawley, "Electronics and Instrumentation in the Glass Industry," J. R. Beattie, 5.30 p.m.

Advanced Engineering Courses

The Principles of Radiation Protection. THE REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, Harwell, Berkshire. The fourth advanced radiation protection course comprises lectures, practical work, demonstrations and visits, and is intended for graduates or persons of graduate standard either entering or already working in the field of radiological health and safety. The course will cover a wide field of fundamental background knowledge and will deal with principles rather than with particular techniques. A high academic standard is set, but since few academic course cover all the necessary subjects, the course of lectures will begin with first principles, and will not require previous specialised knowledge.
The theoretical part of the course consists of about 110 lectures under three main headings, "Basic Scientific Principles," "Principles of Radiation Protection" and "General Topics."
The course runs from April 19 to July 18, 1961. Fee £250 exclusive of accommodation.

Production Planning and Control. THE UNIVERSITY OF BIRMINGHAM, Institute for Engineering Production, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. The primary aim of the course is to discuss methods of production planning and control and the application of systematic analysis to these functions with a view to the improvement of organisational and production efficiency. The course is intended for industrial executives, senior production engineers and controllers, O. and M. personnel and other specialists in related fields. The course runs from Monday, February 6, until Friday, February 17, 1961. The inclusive charge for the two week residential course is sixty guineas.

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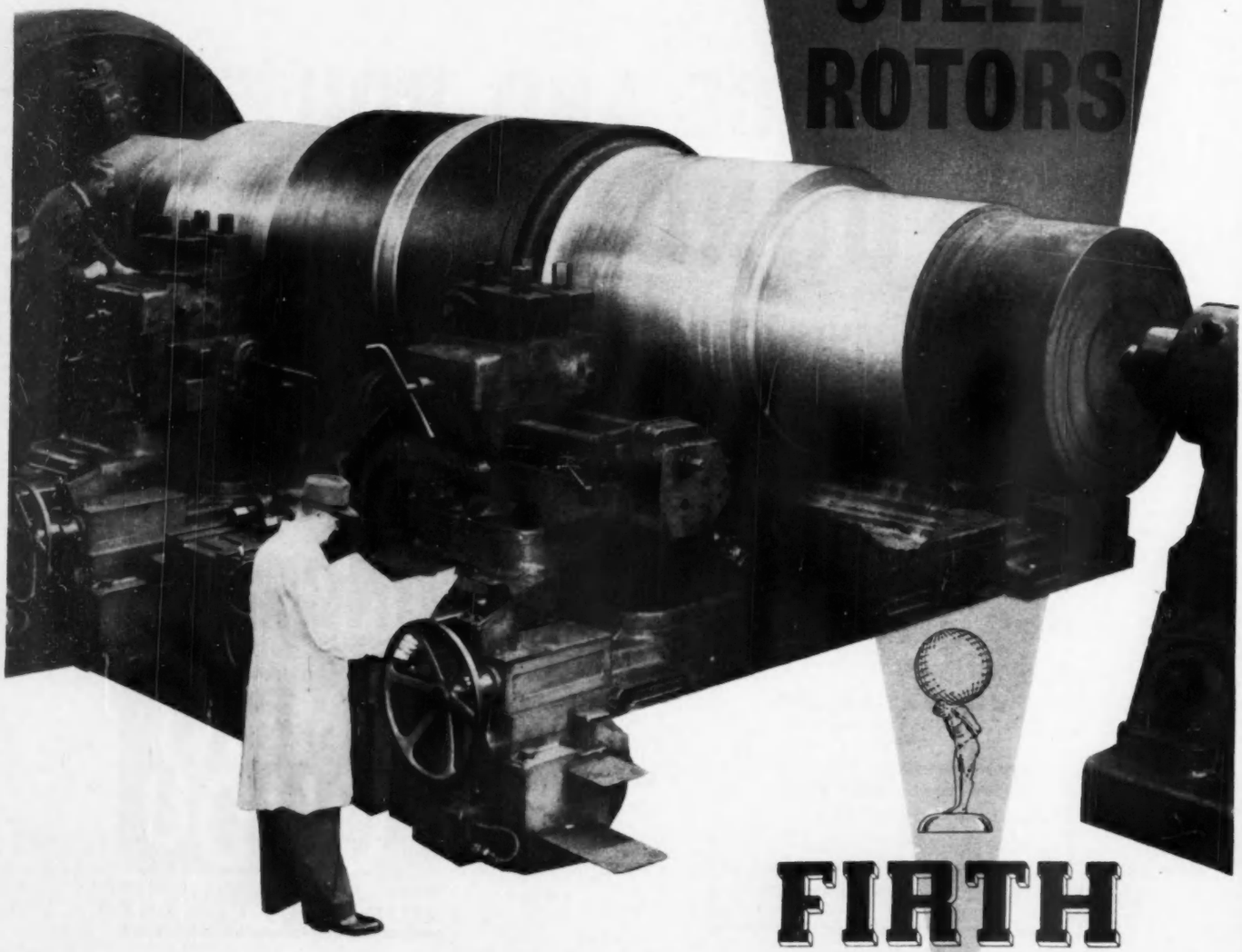

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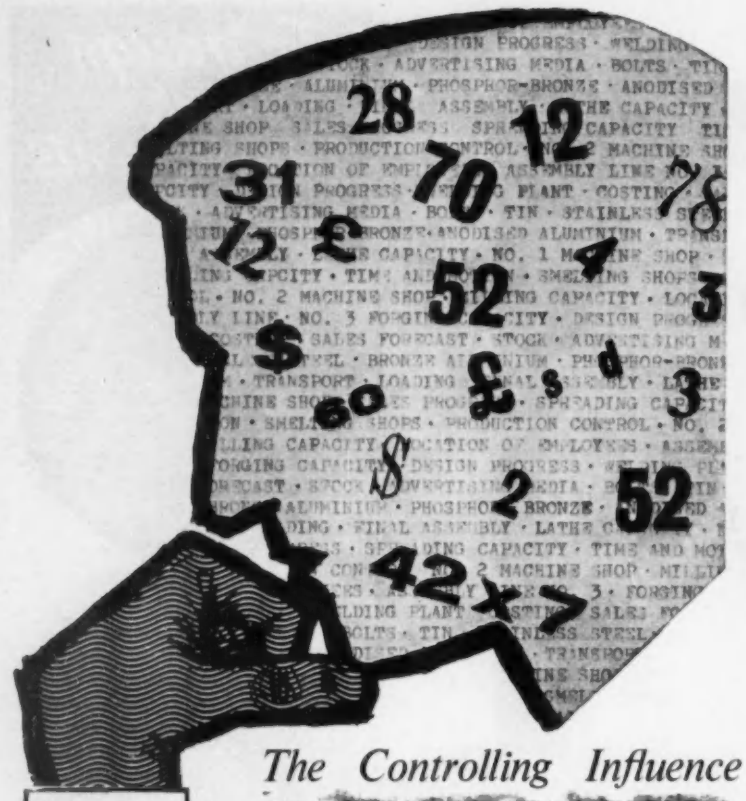

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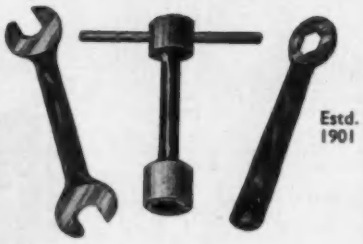

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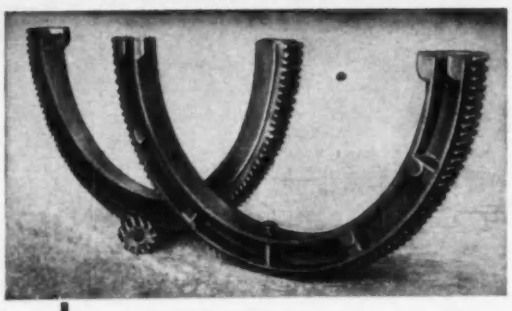

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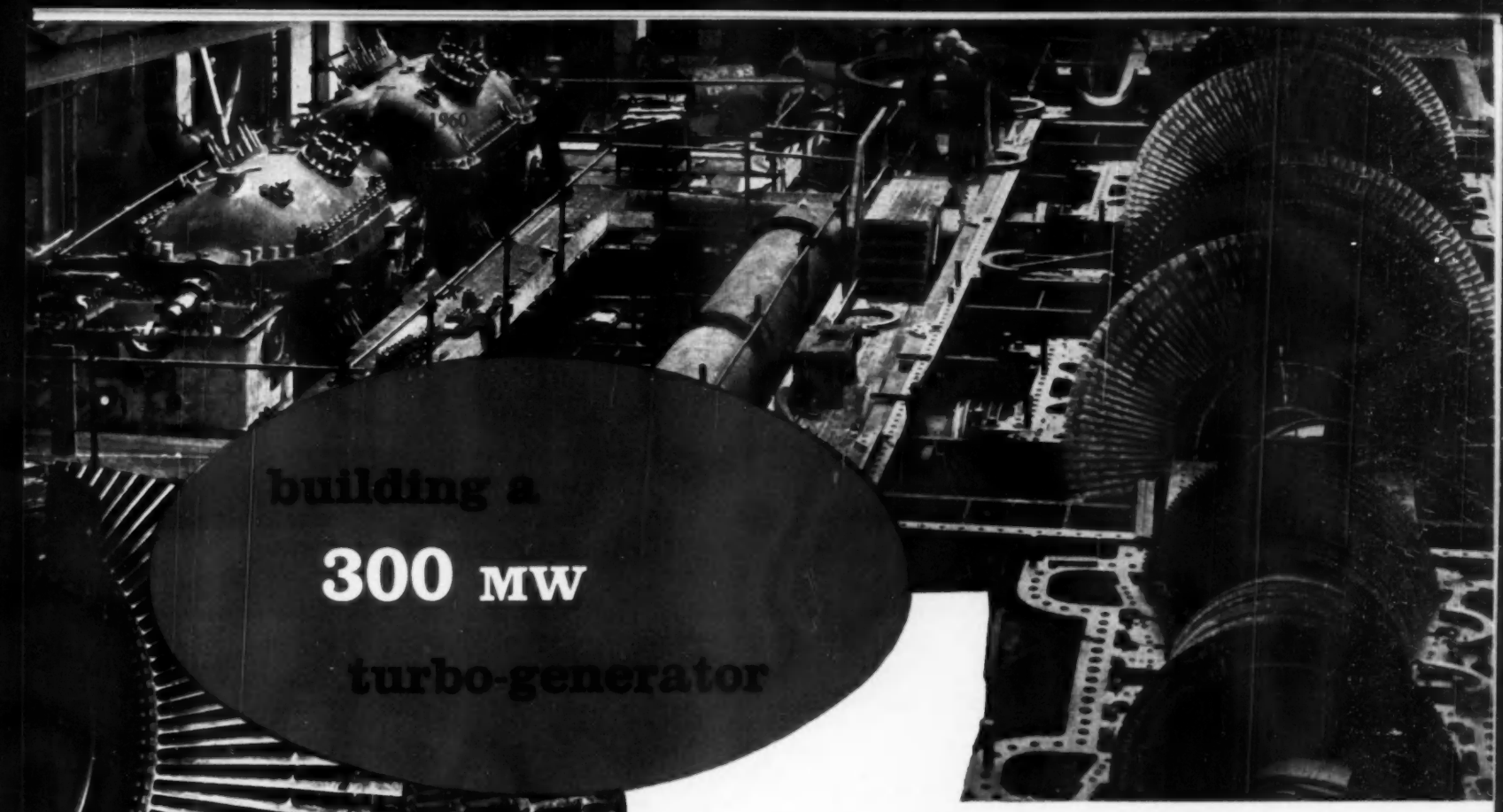

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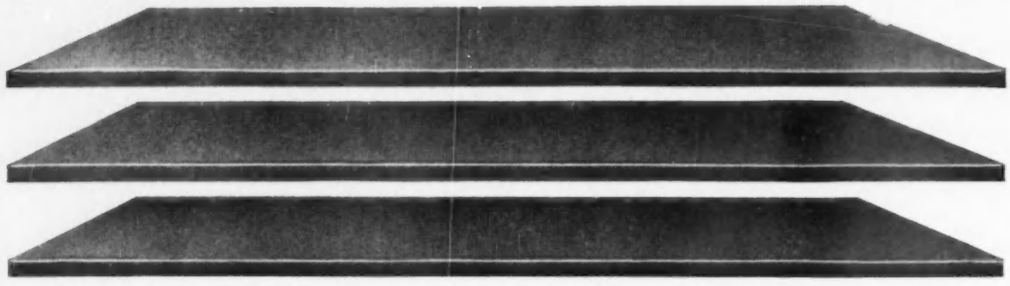

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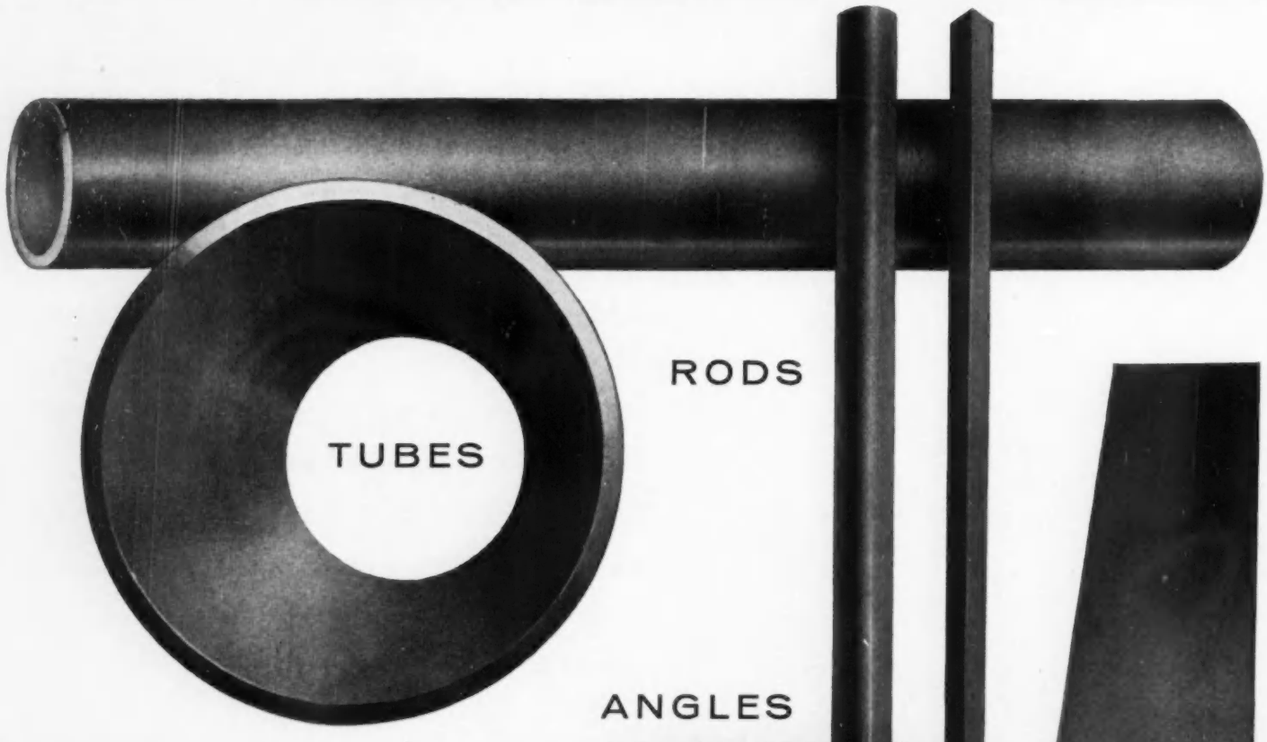

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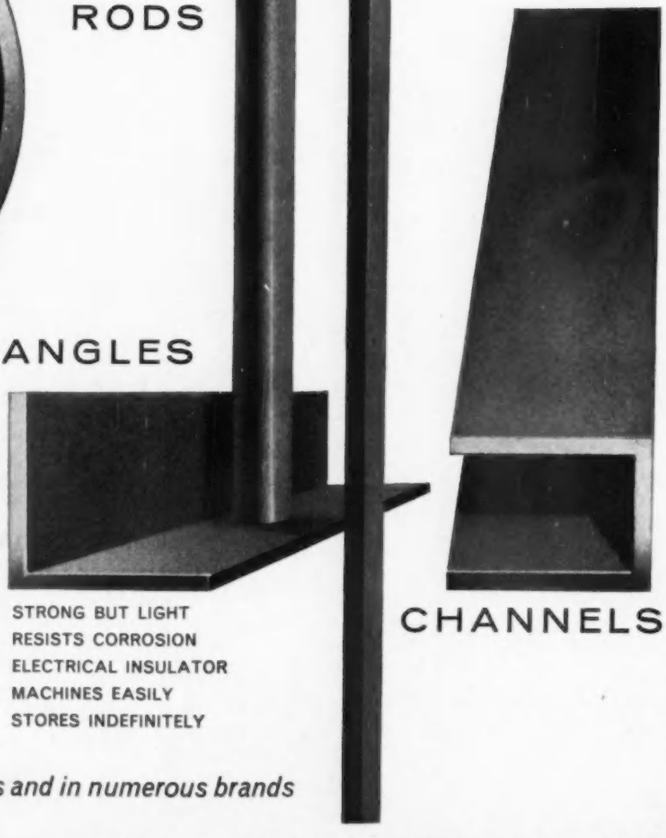

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HOLLOW STRUCTURAL STEEL

This tower crane, 130 ft. high, was constructed by Ruston-Bucyrus Ltd., of Lincoln, for Abelson and Co. (Engineers) Ltd., of Birmingham.

The half-scale drawing shows a detail of the tower structure and illustrates the ease of fabrication when Rectangular Hollow Sections are used in conjunction with round steel tubes.

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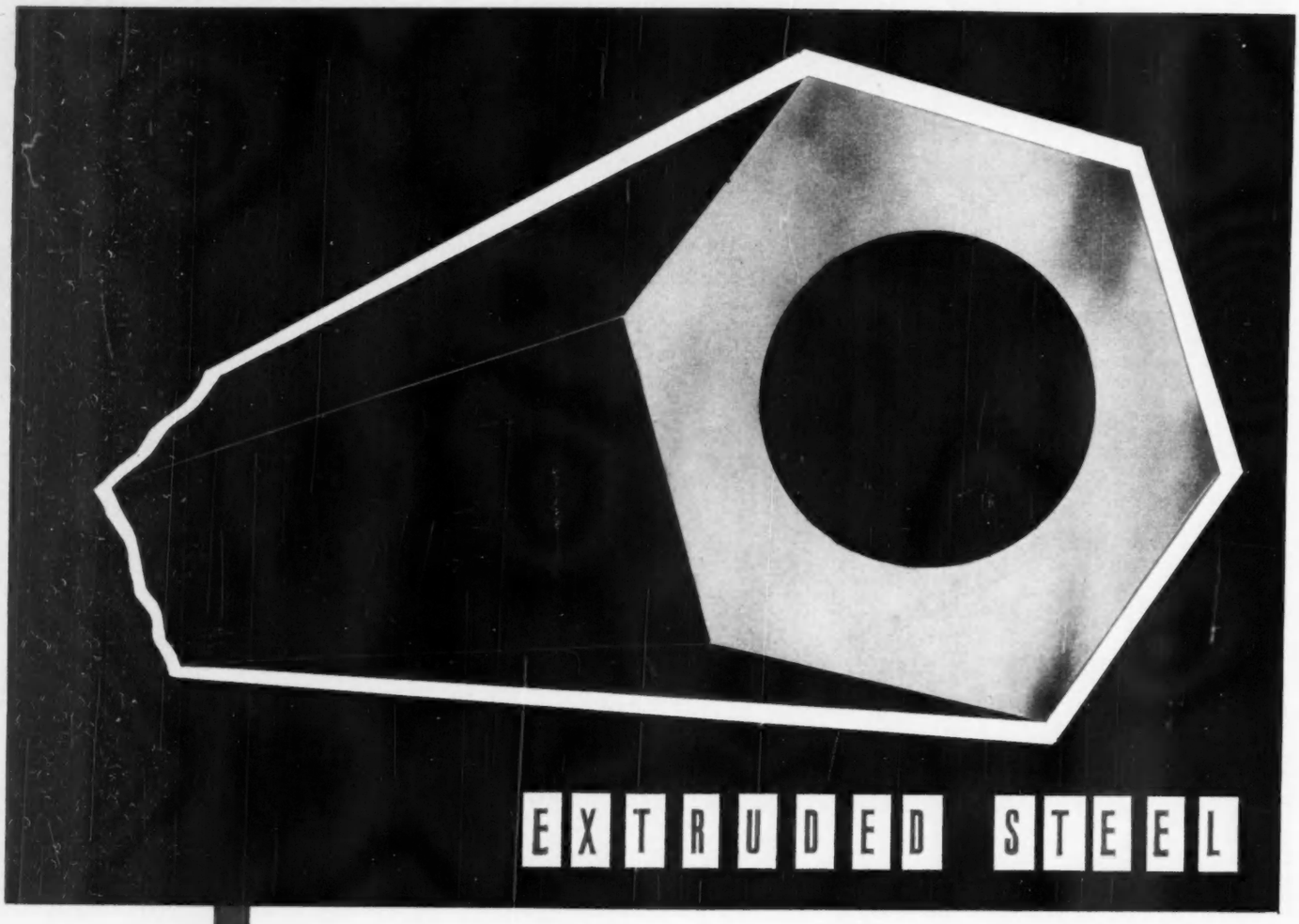

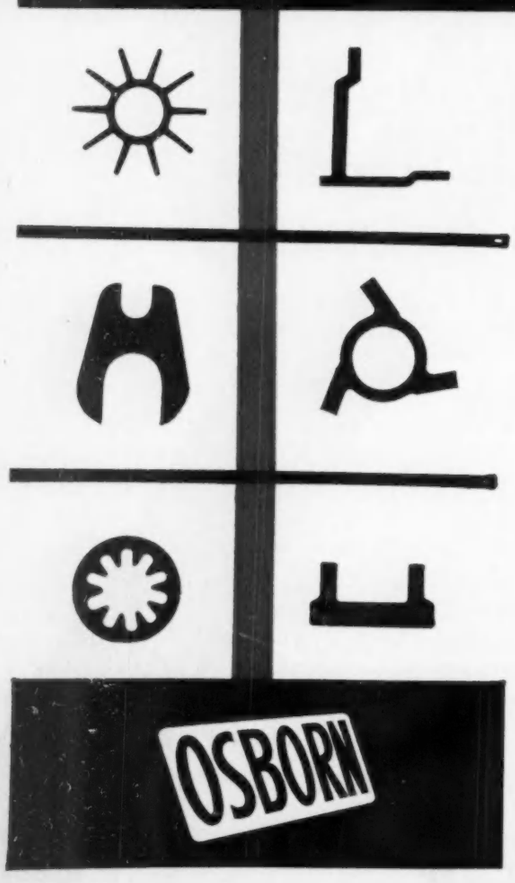

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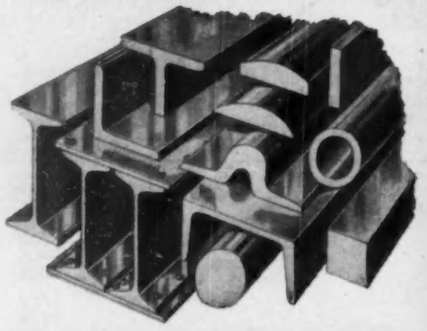

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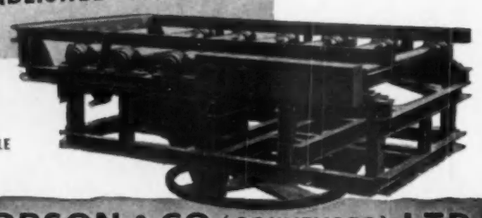

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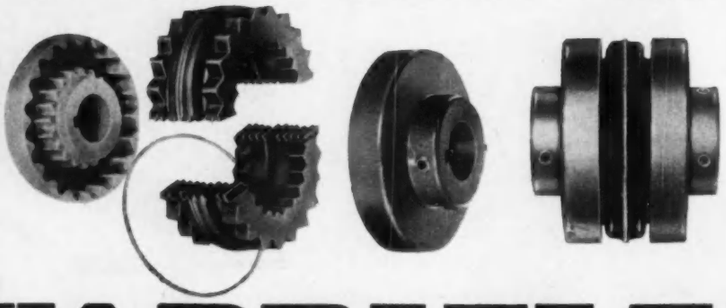

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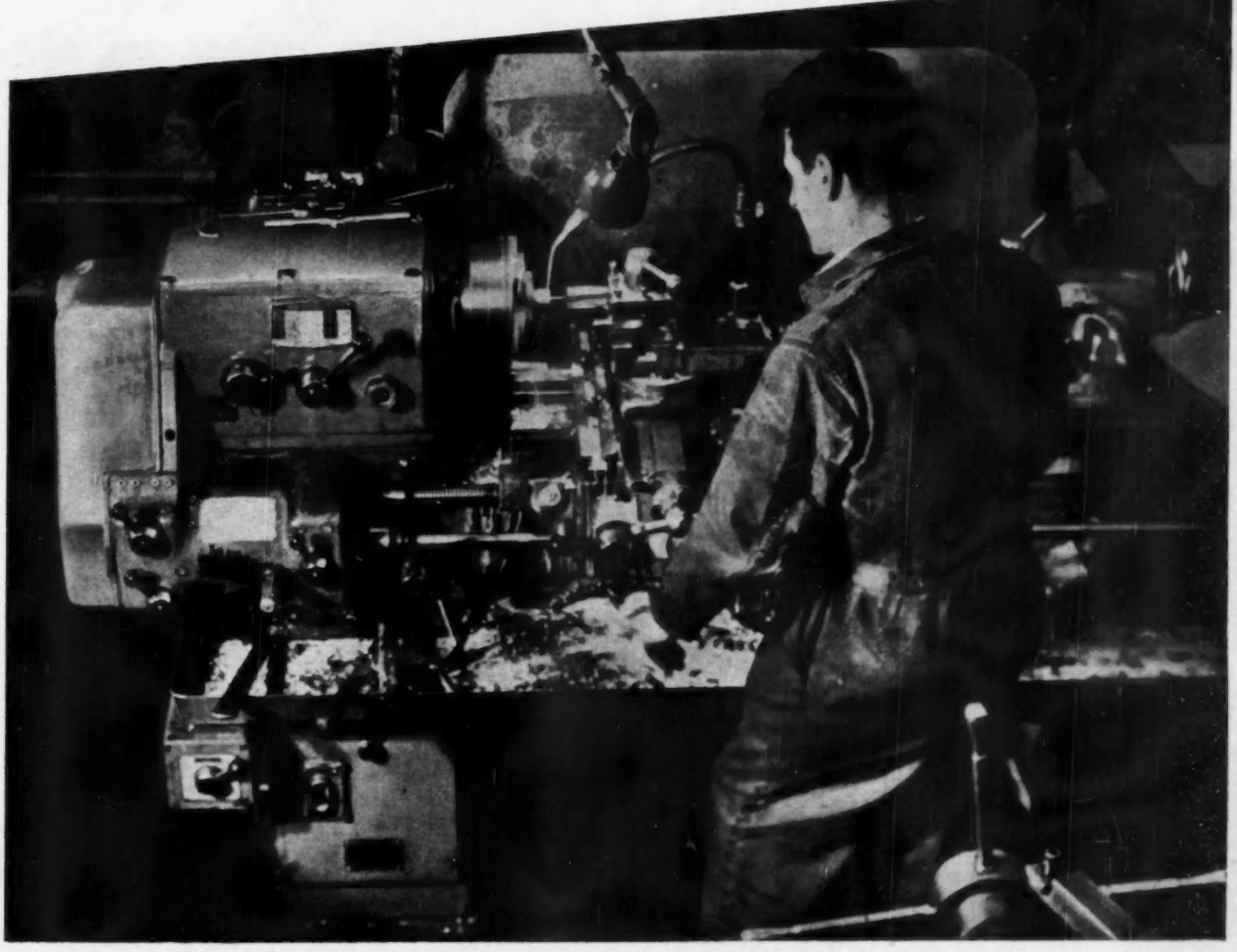

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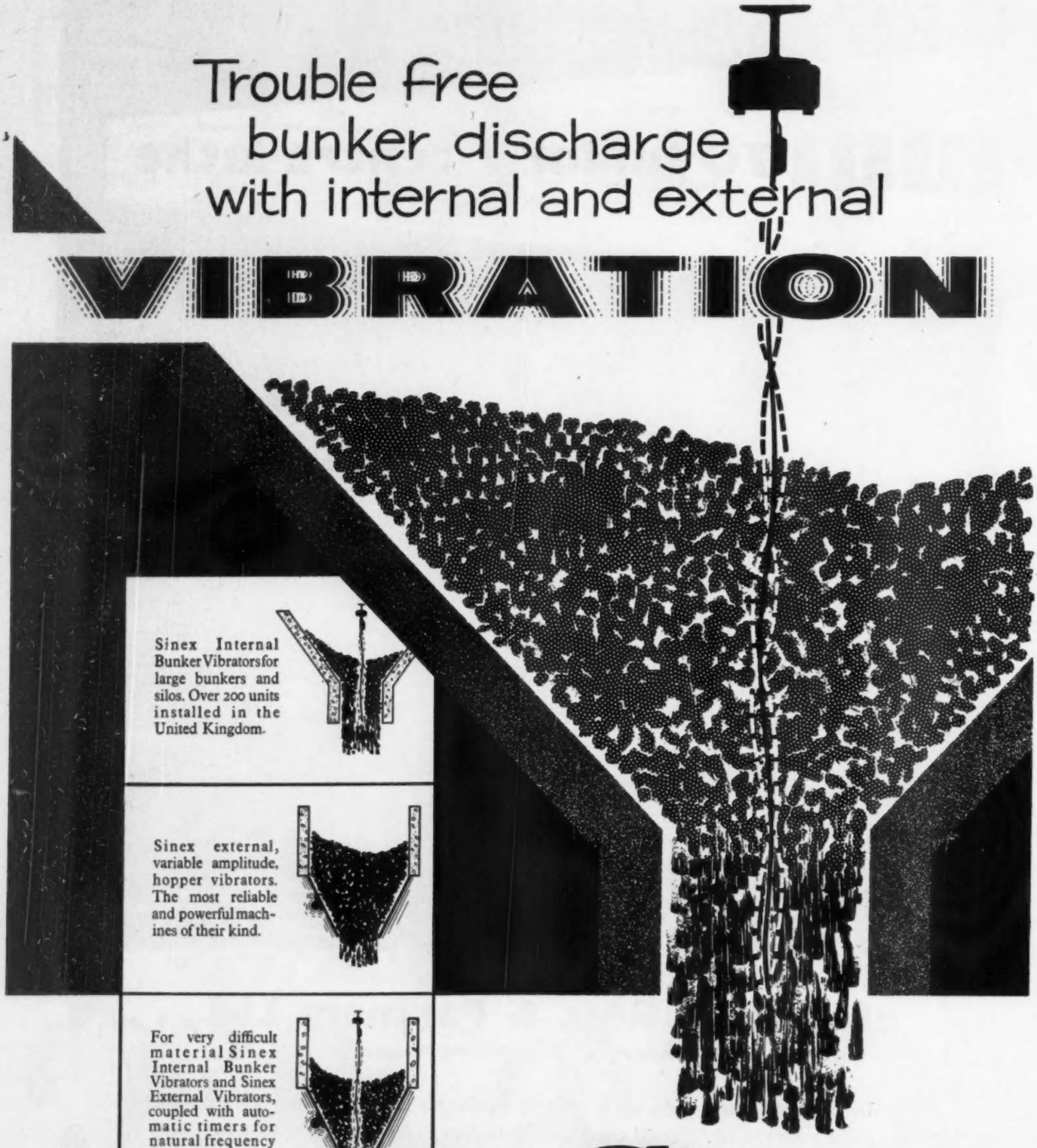

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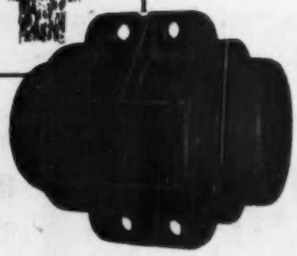

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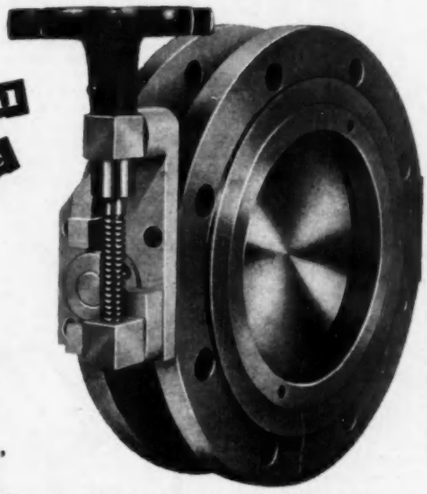

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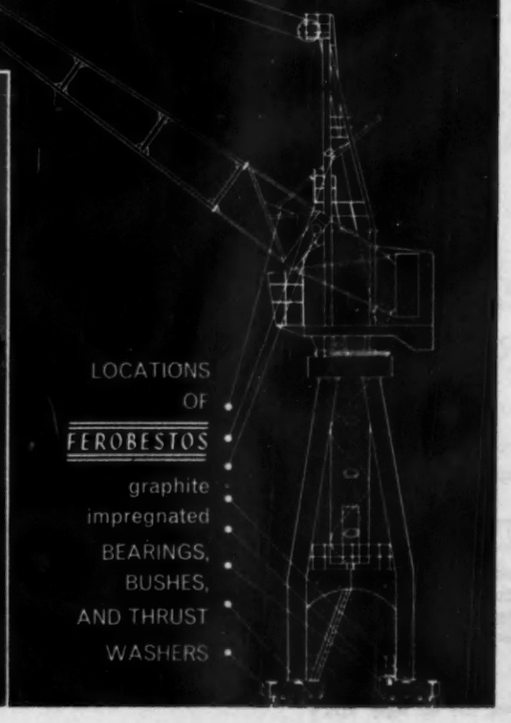

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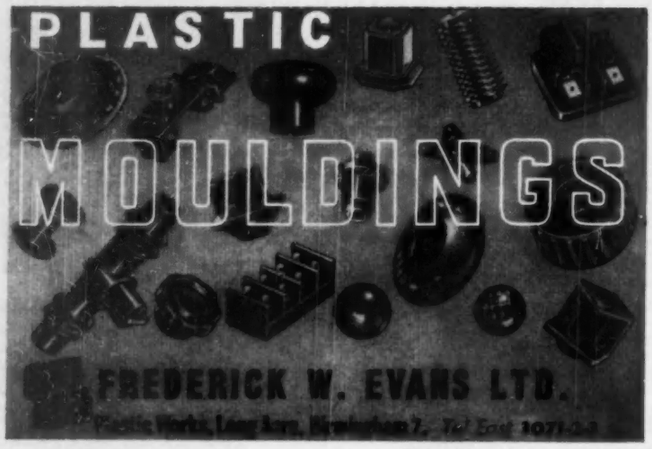

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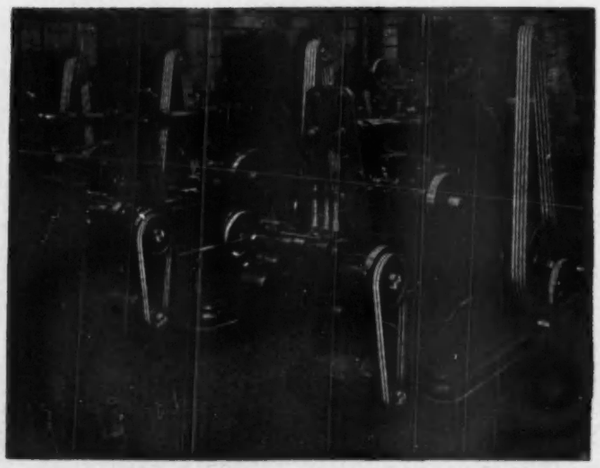

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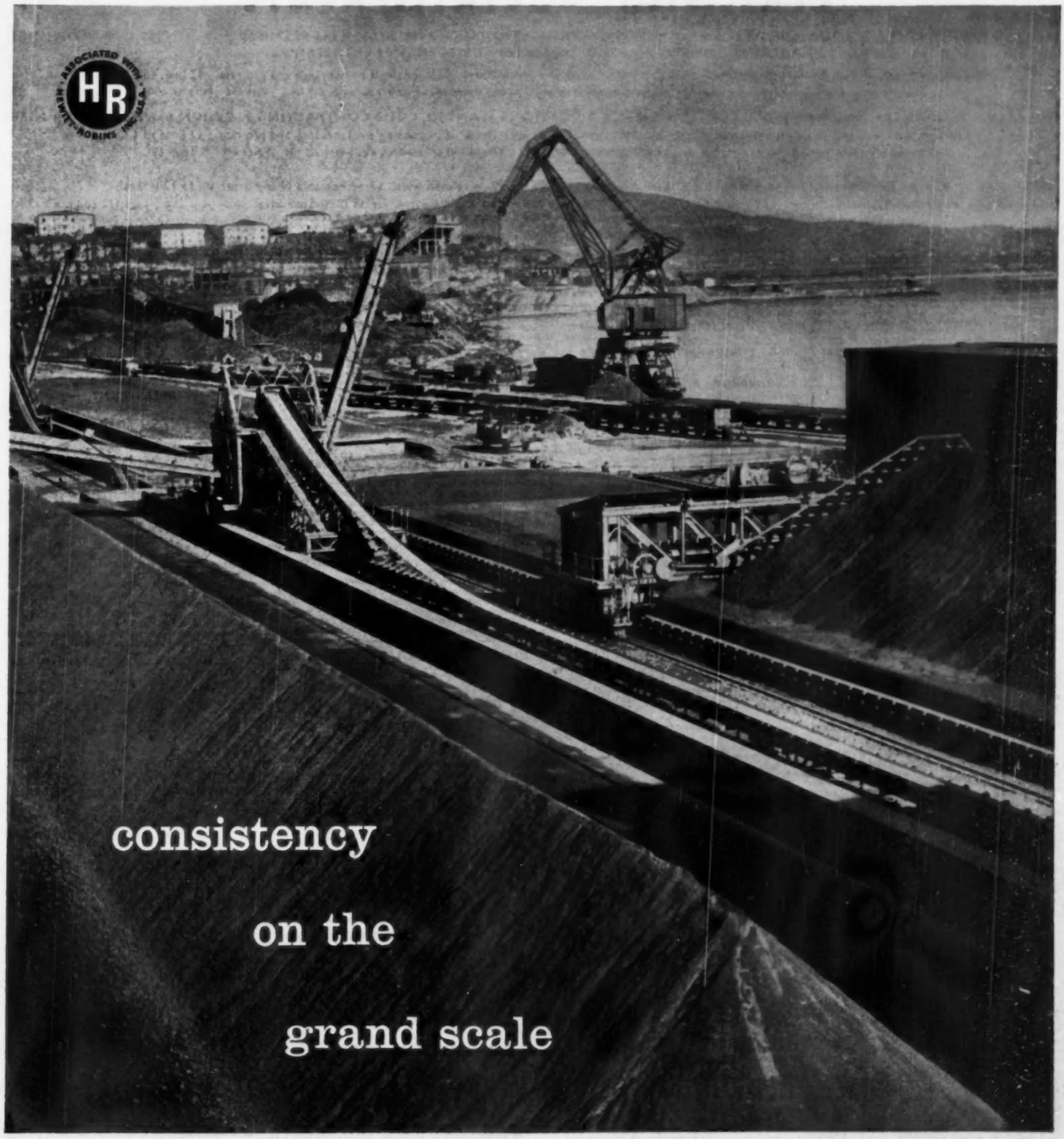

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The University invites applications for appointment to positions of SENIOR LECTURERS and LECTURERS in the following schools of the Faculty of Engineering. Applicants should be qualified to teach in one or more of the fields listed.

CIVIL ENGINEERING : Materials, structures, surveying.

ELECTRICAL ENGINEERING : Automatic control, communications, computers and power systems. (One vacancy for a Senior Lecturer exits at Wollongong, to take charge of degree instruction in Electrical Engineering).

INDUSTRIAL ENGINEERING : Methods engineering, design, production control.

MECHANICAL ENGINEERING : Thermodynamics, theory of machines, fluid mechanics, design and drawing, servomechanisms.

HIGHWAY ENGINEERING.

For appointment as Lecturer, applicants should possess an appropriate degree with honours or equivalent qualifications and have had previous lecturing and industrial experience ; for appointment as Senior Lecturer, applicants should possess a higher degree or have published research papers evidencing their ability to lecture at post-graduate level and to supervise research programmes.

Salary ranges : Senior Lecturer : £A2579 to £A3029 p.a. Lecturer : £A1759 to £A2464 p.a.

Subject to passing a medical examination, appointees will be eligible to contribute to the State Superannuation Fund.

First-class ship fares to Sydney of appointees and their families will be paid.

Four copies of applications (including the names of two referees and quoting reference HB) should be lodged with the Agent General for New South Wales, 56 Strand, London, W.C.2, and a copy forwarded by airmail in an envelope marked "University Appointment" to the Bursar, The University of New South Wales, Box 1, Post Office, Kensington, New South Wales, Australia, before 20th January, 1961. Applicants outside the United Kingdom and Ireland need only submit one copy of their applications to the London address. E7404

QUEEN'S UNIVERSITY OF BELFAST

SENIOR LECTURESHIP IN ENGINEERING MATHEMATICS

The Senate of The Queen's University of Belfast invites applications for a SENIOR LECTURESHIP in charge of the Department of Engineering Mathematics from 1st October, 1961. The Department is responsible for teaching mathematics to engineering students throughout the University and candidates should preferably have a research interest in the application of mathematics to some engineering subject. Salary range £1700 to £2275 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience. Applications should be received by 30th January, 1961. Further particulars may be obtained fromG. R. Cowie, M.A., LL.B., J.P., Secretary to the University. E7414

OXFORD UNIVERSITY

UNIVERSITY SURVEYOR'S OFFICE

MECHANICAL ENGINEER

There is a vacancy in the University Surveyor's Office, for a MECHANICAL ENGINEER to co-ordinate the design of heating, ventilating and electrical equipment and plant in new building projects. He will be responsible under the Surveyor for liaison between departments and architects and specialist consultants, and will also be required to exercise a general supervision of the maintenance and repair of existing installations.

He must be a qualified mechanical or electrical engineer, or a graduate in engineering. Salary will be in the range £1500 to £1850. The successful applicant will be entitled to membership of the Federated Superannuation System for Universities, and would qualify for children's allowances of £50 per child per annum.

Further details and forms of application from the Surveyor to the University, The Malthouse, Tidmarsh Lane, Oxford. E7375

PUBLIC APPOINTMENTS

UNIVERSITY OF WALES

UNIVERSITY COLLEGE OF SWANSEA

DEPARTMENT OF ENGINEERING

APPOINTMENTS

Owing to the large expansion of the Departmental facilities for both teaching and research, a number of appointments will be made to the Staff both immediately and from October 1st, 1961. Applications are invited from graduates in Engineering, Physics, Metallurgy or Applied Mathematics for the following posts :

Civil Engineering :
Professor B. G. Neal.

LECTURER or Assistant Lecturer with interests in any branch of Civil Engineering.

Civil or Mechanical Engineering

LECTURER or Assistant Lecturer with special interests in Strength of Materials and related fields.

Mechanical Engineering :
Professor R. H. Macmillan.

TWO LECTURERS or Assistant Lecturers, one with particular interests in the fields of Heat Transfer and Thermodynamics, the other preferably having experience in the Design of Machines, but applicants with other interests will be considered.

RESEARCH DEMONSTRATOR to undertake a limited amount of teaching and pursue supervised research preferably in Heat Transfer, Hydrodynamic power transmission, Fatigue or creep.

Electrical Engineering :
Professor W. Fishwick.

LECTURER or Assistant Lecturer with special interests in Control Engineering, Electrical Apparatus or related fields.

LECTURER or Assistant Lecturer with interests in any branch of Electrical Engineering, including Theoretical Electro-technics.

Qualifications for, and further details of, these posts are as follows :

LECTURER. Applicants should hold a good Honours degree and have not less than three years post-graduate experience in research or industrial design. Excellent facilities exist for research.

ASSISTANT LECTURER. Applicants should hold a good Honours degree and have at least one year's industrial or post-graduate experience. Research is strongly encouraged and the assistant may register for a Ph.D. degree.

RESEARCH DEMONSTRATOR. Applicants should have obtained a good Honours degree and have had at least one year's industrial or post-graduate experience. The appointment will be tenable for three years, during which time the holder will be expected to work for the Ph.D. degree, submitting a thesis at the end of the period.

Salaries are on the following scales, to which are added F.S.S.U. benefits and family allowances.

Lecturer : £1050 by £50 to £1400 by £75 to £1850 per annum.

Assistant Lecturer : £800 by £50 to £950 per annum.

Research Demonstrator : £700 per annum.

Further particulars can be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications (two copies) must be received not later than Saturday, January 21, 1961. E7418

UNIVERSITY OF NEW SOUTH WALES

AUSTRALIA

FACULTY OF ENGINEERING

TEACHING FELLOWS

Vacancies for TEACHING FELLOWS exist in the Schools of Mechanical, Electrical and Civil Engineering. Applicants must possess a degree with honours, and will be expected to enrol for a higher degree and undertake a limited amount of teaching duties. Engagement is on an annual basis to a maximum of three years.

Salary : £A1129 range £A1349 p.a.

Commencing salary for all positions will be according to qualifications and experience.

Further details regarding these positions may be obtained from the Head of the appropriate school.

Ship fares to Sydney of appointees and their families will be paid.

Four copies of applications (including the names of two referees) should be lodged with the Agent General for New South Wales, 56-57 Strand, London, W.C.2, and a copy forwarded by airmail to the Appointments Section, The University of New South Wales, Box 1, Post Office, Kensington, New South Wales, Australia, before 27th January, 1961. E7420

PUBLIC APPOINTMENTS

UNIVERSITY OF ABERDEEN AND ROBERT GORDON'S COLLEGES

UNIVERSITY LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the post of UNIVERSITY LECTURER IN MECHANICAL ENGINEERING. Candidates should have special qualifications in applied thermodynamics. An interest in Heat Transfer apparatus and some industrial or research experience would be an advantage. Excellent facilities for research or advanced studies. Univer ity regulations permit members of teaching staff to read for degree of Ph.D. by research. Salary on scale £1050 to £1850 with placing according to qualifications and experience. University houses available from time to time. Appointment to date from as early as possible in 1961.

Further information may be obtained from the Secretary, The University, Aberdeen, with whom applications (20 copies), giving the names of three referees, should be lodged not later than 31 January, 1961. Applicants outside the British Isles may submit one copy of application. E7443

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

LEICESTERSHIRE

DEPARTMENT OF MECHANICAL ENGINEERING

TWO RESEARCH VACANCIES

Applications are invited from suitably qualified engineers or physicists to fill TWO RESEARCH VACANCIES in the Department of Mechanical Engineering. One of the posts is in the field of Mechanical Vibrations and the other is concerned with Hydraulic and Pneumatic Control Systems.

Previous industrial or research experience is desirable, but those recently graduated with a good honours qualification also considered.

Salary, dependent on qualifications and experience, up to £750 p.a.

Application forms or further information from Academic Registrar quoting Ref. 25/C. E7437

NATIONAL ENGINEERING LABORATORY (D.S.I.R.)

EAST KILBRIDE, GLASGOW

EXPERIMENTAL OFFICERS/ ASSISTANT EXPERIMENTAL OFFICERS

National Engineering Laboratory (D.S.I.R.), East Kilbride, Glasgow, requires EXPERIMENTAL OFFICERS/ASSISTANT EXPERIMENTAL OFFICERS for design and development engineers in the field of Fluid Flow, Heat Transfer, Lubrication, Materials and Mechanisms. Qualifications : E.O. (at least age 26). Pass degree in engineering H.N.C. of G.I.Mech.E. or equivalent. A.E.O.: Scottish Leaving Certificate with passes in 5 subjects, of which 3 must be in Higher Grade, including 2 in scientific or mathematical subject. Salary (Men) E.O.: £1015 to £1245 ; A.E.O.: £432 (age 18) to £745 (age 26) to £920. Houses are available for married staff. Prospects of permanent pensionable posts for suitable candidates. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1. Quoting C 964/OA. Closing date 6 January, 1961. E7406

EAST RIDING HOSPITAL MANAGEMENT COMMITTEE

APPOINTMENT

Successful candidate will be responsible for the maintenance and operation of steam generating plant, electrical mechanical engineering services and heating systems, and should possess an Engineering degree ; A.M.I.Mech.E. or equivalent qualification. Knowledge of minor road repairs and sewage work operation an advantage. Salary : £1070 by £30 (2) by £35 (3) to £1235.

Detailed applications giving 2 Referees to Group Secretary, Westwood Hospital, Beverley, Yorkshire. E7412

PUBLIC APPOINTMENTS

CITY OF SHEFFIELD

CITY ENGINEER AND SURVEYOR'S DEPARTMENT

APPOINTMENTS

Applications are invited from suitably qualified persons for the following appointments on the staff of the City Engineer and Surveyor :

(a) ASSISTANT CITY SURVEYOR—Grade "F" (£2015 to £2345 p.a.). (b) PRINCIPAL ASSISTANT—Grade "D" (£1710 to £1975 p.a.). (c) SENIOR ASSISTANT (Bridges)—Grade "B" (£1480 to £1670 p.a.). (d) SENIOR ASSISTANTS (Highways Bridges and Traffic Engineering Sections) Grade A.P.T. V (£1310 to £1480 p.a.).

Candidates for post (a) will be required to take charge of the Outdoor Works Section and must have good experience in the control of a large direct labour organisation embracing ex ensive repair workshops. Candidates for post (b) must have a sound knowledge of highway design and reconstruction work in city centres.

Commencing salary for each post will be in accordance with experience and qualifications.

Consideration will be given if required to assistance with housing accommodation and removal expenses in suitable cases.

Superannuable posts, N.J.C. Conditions of Service, Medical Examination.

Applications, stating age, education and training, qualifications, experience, present and past appointments (with dates and salaries) and quoting the names of two referees should be submitted to the undersigned by the 30th December, 1960.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield 1. E7341

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

APPOINTMENT OF DEPUTY REGIONAL ENGINEER

Applications are invited for the appointment of DEPUTY REGIONAL ENGINEER to the Board. This is a responsible post in the team serving the largest Board in the country which is now carrying out an expanding programme of hospital building. The successful applicant must be capable of acting for the Regional Engineer over the whole range of the services for which he is responsible. This is a post requiring considerable ability and initiative.

Applicants must hold corporate membership of the Institution of Civil, Mechanical, Electrical, or Structural Engineers, and preference will be given to candidates with considerable experience of large engineering installations in hospitals or public buildings.

The salary is £2015 p.a., rising to £2415 p.a. by four annual increments. This includes a London Weighting allowance.

Enquiries for further particulars may be made to the undersigned.

Applicants are asked to give full particulars of their age, qualifications and experience, and these together with the names of two referees, should be sent to the Secretary at 40, Eastbourne Terrace, W.2, with confidential cover and marked "Deputy Regional Engineer" by 6th January.

E. G. BRAITHWAITE,
Secretary.
E7432

LEWISHAM GROUP HOSPITAL MANAGEMENT COMMITTEE

SUPERINTENDENT ENGINEER

Applications are invited for the position of SUPERINTENDENT ENGINEER who will be responsible for the operation, maintenance and co-ordination of the engineering services and activities, in this large and important group of hospitals ; the supervision of maintenance works and staff, and the keeping of all necessary records, &c. Post vacant 1 April, 1961.

Applicants should be qualified in accordance with the Ministry of Health requirements.

Salary scale : £1130 to £1325, plus £50 London Weighting Allowance. In addition, at the present time, a long hours gratuity at the rate of 6½ per cent of salary is also payable.

Applications, giving details of qualifications and experience, present and previous posts, &c., together with the names and addresses of two referees, should be sent to the Group Secretary, Lewisham Hospital, Lewisham, London, S.E.13, by not later than 21 January, 1961. E7430

PUBLIC APPOINTMENTS

DEPARTMENT OF MAIN ROADS

NEW SOUTH WALES, AUSTRALIA

CIVIL ENGINEERS

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road constructions and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1325 to £A1650 per annum, with annual progression, subject to technical competence to £A2400 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56 Strand, London, W.C.2. Please quote No. 44/31 when writing. E7291

PUBLIC APPOINTMENTS

TRENT RIVER BOARD

APPOINTMENT OF ASSISTANT ENGINEER II

Applications are invited for the appointment of ASSISTANT ENGINEER II in the Board's Divisional Office at Tamworth. Salary—A.P.T. Grades I–III : (£645 to £1140) or A.P.T. III–IV : (£960 to £1310).

N.J.C. service conditions with car allowance on "Essential User" scale and Assisted Car Purchase Scheme is operated by the Board. The commencing salary within the Grades mentioned will be according to qualifications and experience but normally the appointment will be made in the lower half of the ranges.

The successful applicant will be engaged mainly on the design and supervision of river improvement schemes carried out by either contract or direct labour. Applications from University students who expect to graduate in 1961 will also be considered.

Applications, including copies of testimonials or names of two referees, to the Engineer, Trent River Board, 206, Derby Road, Nottingham, by 16th January, 1961.

IAN DRUMMOND,
Clerk of the Board.

E7419

PUBLIC APPOINTMENTS

CITY OF CARDIFF

CORPORATION WATERWORKS

APPOINTMENT OF ENGINEERING ASSISTANT

Applications are invited from suitably qualified Civil Engineers for the permanent appointment of ENGINEERING ASSISTANT (A.P.T. Grade III—£935 to £1140 p.a.) on the staff of the Water Engineer and Manager.

General conditions and further details of this Appointment can be obtained from the Water Engineer and Manager, Municipal Offices, Greyfriars Road, Cardiff, and applications stating age, previous experience and qualifications, together with the names of two referees, should reach the undersigned in envelopes appropriately endorsed, not later than Wednesday, 28th December, 1960.

S. TAPPER-JONES,
Town Clerk.

City Hall,
Cardiff,
December, 1960. E7343

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF HUDDERSFIELD

WATERWORKS DEPARTMENT

DEPUTY ENGINEER

Applications are invited for the appointment of DEPUTY ENGINEER in the Waterworks Department.

Salary : £1560 per annum rising by four annual increments to £1810 per annum. The appointment is subject to the provisions of the Local Government Superannuation Acts and the successful candidate will be required to pass a medical examination.

Applications, stating date of birth and full particulars of qualifications and experience, with names and addresses of three referees, to be received by the undersigned not later than 14th January, 1961.

HARRY BANN,
Town Clerk.

Town Hall,
Huddersfield. E7389

Mechanical Engineers and Draughtsmen

required by Welsh Regional Hospital Board for Large Scale Hospital Building Programme

POSITIONS VACANT	QUALIFICATIONS	SALARY SCALE
(a) Mechanical Engineer Main Grade	(1) Corporate Members of the Institution of Mechanical or Heating and Ventilating Engineers. (2) Graduate members with at least five years' experience who have passed Parts I and II of the Associate Membership Examination of the Institution of Mechanical Engineers or Sections A and B of the Associate Membership Examination of the Institution of Heating and Ventilating Engineers.	**£910 by £35(1) by £40(2) by £45(5) by £50(7) to £1,600.** Bar at £1,400 for associate members of I.H.V.E. Bar at £1,205 for graduate members. Corporate members enter scale at £1,160.
(b) Mechanical Engineering Assistant	Pass in Parts I and II of the Examination of the I.Mech.E. OR Parts A and B of the Associate Membership Examination of the I.H.V.E. OR H.N. Diploma OR H.N. Certificate OR a recognised engineering degree PLUS practical training and site experience.	**£600 (age 21) by £25(4) by £30(5) by £35(4) by £40(2) to £1,070.** £50 deduction where none of the specified qualifications are held and a qualification Bar at £920. Corporate members enter scale at £850.
(c) Mechanical Engineering Draughtsmen	**Grade 2 :** H.N.C. OR Sections A and B of the I.H.V.E. Examination or an equivalent qualification preferred, and suitable practical and theoretical training PLUS good experience.	**£870 by £35(4) to £1,010.**
	Grade 3 : 3 years' practical and theoretical training including site or workshop experience and technical experience in engineering drawing.	**£550 by £25(2) by £30(6) by £35(2) to £850.**

New entrants to the Health Service will be appointed at the minimum of the appropriate salary scale except as follows :—

The Board has discretion to authorise a commencing salary above the minimum scale, within certain limits, for posts (a) Main Grade Engineer, (b) Engineering Assistant and (c) Engineering Draughtsmen (Grade 3 only), where it is considered a candidate has relevant practical experience appropriate to the post to be filled.

Offices situated in Cardiff's City Centre. All posts are superannuable and a five-day week applies.

Applications to Secretary, Welsh Regional Hospital Board, Temple of Peace and Health, Cathays Park, Cardiff, stating age, qualifications, experience present position and salary and names of two referees within 14 days.

E7407

PUBLIC APPOINTMENTS

MERSEY DOCKS AND HARBOUR BOARD

ASSISTANT ENGINEER-IN-CHIEF

Applications are invited for appointment to the above post at an initial salary up to £3000 per annum, depending on qualifications and experience. Candidates must be fully trained and qualified Civil Engineers with wide experience in the design and execution of port works and at present hold a senior position with a Port Authority or Contractor.

There is a prospect of early promotion to the post of Principal Assistant and candidates must therefore possess good executive and administrative ability as well as high technical qualifications.

After a satisfactory probationary period the person appointed would be subject to the Board's Conditions of Service.

Applications should be received by the undersigned not later than the 30th January, 1961 and be marked "Assistant Engineer-in-Chief."

A. S. MOUNTFIELD,
General Manager and Secretary.

Dock Office,
Liverpool, 3. E7350

RUNWELL HOSPITAL

NEAR WICKFORD, ESSEX

SENIOR ENGINEER

SENIOR ENGINEER required. Must hold Ministry of Transport and Civil Aviation First Class Certificate of competency in Marine Engineering, Certificate of Service as First Class Engineer, City and Guilds Full Technological Certificate in Plant Engineering (First Class) or approved equivalent qualification.

Health Service Whitley Council conditions ; pensionable ; Present salary scale £765 to £910. The Officer will act as Deputy to the Superintendent Engineer and will be required to occupy the house provided (present rent £1 14s. 5d. a week subject to variation).

Applications, quoting two referees, to the Secretary within 14 days. E7446

TENDERS

KINGDOM OF THAILAND

ROYAL IRRIGATION DEPARTMENT, BANGKOK, THAILAND

INVITATION FOR BIDS—NO. YS-2-17

The Royal Irrigation Department of the Kingdom of Thailand hereby invites SEALED WRITTEN BIDS for FURNISHING and DELIVERING the following EQUIPMENT either f.o.b. Contractor's shipping point or c.i.f. Bangkok Wharf, Thailand, for the Bhumiphol Power Plant, Yanhee Multi-purpose Project, Kingdom of Thailand, in accordance with the Contract Documents :

Three (3) Cooling Water Pumps, centrifugal type, capacity 5680 litres per minute (1550 g.p.m.), total head 18 metres (60ft.) ;
Two (2) Cooling Water Pumps, centrifugal type, capacity 1930 litres per minute (510 g.p.m.), total head 17 metres (55ft.) ;
One (1) Water Booster Pump, regenerative turbine type, capacity 190 litres per minute (50 g.p.m.), total head 120 metres (400ft.) ;
One (1) Water Booster Pump, regenerative turbine type, capacity 53 litres per minute (14 g.p.m.), total head 22 metres (75ft.) ;
Two (2) Water Sump Pumps, vertical turbine type, capacity 17,000 litres per minute (4500 g.p.m.), total head 15 metres (50ft.) ;
Two (2) Water Sump Pumps, vertical turbine type, 2300 litres per minute (600 g.p.m.), total head 36 metres (120ft.) ;
Four (4) oil pumps, rotary gear type, 76 litres per minute (20 g.p.m.) at 7 kg per sq. cm. (100 p.s.i.) discharge pressure.

Invitations for Bids will be issued in January, 1961, and will be opened in March, 1961. Copies of Contract Documents, Invitation for Bids—No. YS-2-17, Water Pumps and Oil Pumps, may be obtained by qualified Bidders on written request to : Royal Irrigation Department, Attention : Thai Liaison Engineer, c/o Engineering Consultants, Inc., 1901 South Navajo Street, Denver 23, Colorado.

Each request must be accompanied by a cheque or money order, payable to the Royal Irrigation Department, in the amount of U.S. $10.00 for each copy of the Contract Documents requested. The remittance is non-returnable.

M. L. XUJATI KAMBHU,
Director General.

Royal Irrigation Department,
Kingdom of Thailand,
Bangkok, Thailand. E7438

PUBLIC APPOINTMENTS

CITY OF LEICESTER

FOREMAN

FOREMAN required for the Sewage Pumping Stations, Misc. VI £760 to £825. Applicants must have served an apprenticeship and had at least 3 years in a supervisory capacity. The Stations include steam and electrically driven pumps, and the new Sewage Works will embody dual/fuel engines. The post is pensionable.

Applications giving the name of two referees to reach the undersigned not later than 9th January, 1961.

JOHN L. BECKETT, M.I.C.E.,
City Surveyor.

Town Hall,
Leicester. E7413

TENDERS

WEST CORNWALL WATER BOARD

DRIFT WATER SCHEME

CONTRACT NO. 7—PIPELAYING

The Board invites FIXED PRICE TENDERS from EXPERIENCED CONTRACTORS for the following work :

CONTRACT No. 7. Supplying, Excavating for, Laying, Jointing, Maintenance and ancillary works, for about 15 miles of SPUN IRON MAINS with Flexible Joints, including all valves and fittings, as follows :

Section A

About	970 yard of	12in. diameter.
"	10,140 " "	10in. "
"	2,380 " "	8in. "
"	695 " "	6in. "
"	370 " "	4in. "
"	330 " "	3in. "

Section B

About	2,315 yards of	6in. diameter.
"	7,405 " "	4in. "
"	1,865 " "	3in. "

The General Conditions, Specification, Bill of Quantities and Form of Tender for this Contract, prepared by the Engineers, Herbert Lapworth Partners, 25, Victoria Street, Westminster, S.W.1, may be obtained from the UNDERSIGNED on or after Wednesday, the 11th January, 1961, on receipt of a cheque for £5 made payable to the West Cornwall Water Board, which sum will be returned on receipt of a bona fide Tender.

Tenders, together with all documents received are to be enclosed in a sealed cover endorsed "Drift Water Scheme—Tender for Contract No. 7—Pipelaying" (Section A and B separately) and addressed to the UNDERSIGNED and delivered not later than 10 a.m. on Monday, 30th January, 1961.

Only Tenders from firms experienced in this type of work will be considered.

The Board do not bind themselves to accept the lowest or any Tender, and reserve the right to accept separate Tenders for Section A or B or one Tender in respect of the whole of the work.

E. O. WHEALE,
Clerk to the Board.

Municipal Buildings,
Penzance,
Cornwall.
16th December, 1960. E7441

WEST CORNWALL WATER BOARD

HAYLE WATER SCHEME

CONTRACT NO. 11

PHILLACK TOWANS RESERVOIR AND PIPELAYING

The Board invites FIXED PRICE TENDERS from EXPERIENCED CONTRACTORS for the construction of a CONCRETE SERVICE RESERVOIR with a capacity of 150,000 gallons at Phillack Towans, and excavating for, Supplying, Laying, Jointing, and the Maintenance of about 1150 yards of 6in. and 4in. diameter asbestos cement pipes, together with valves and fittings &c.

The reservoir is rectangular in plan with normally reinforced concrete walls, columns and flat slab roof.

The General Conditions, Specification, Bill of Quantities and Form of Tender for this Contract, prepared by the Engineers, Herbert Lapworth Partners, 25, Victoria Street, Westminster, S.W.1, may be obtained from the UNDERSIGNED on or after Wednesday, the 11th January, 1961, on receipt of a cheque for £5 made payable to the West Cornwall Water Board, which sum will be returned on receipt of a bona fide Tender.

Tenders, together with all documents received are to be enclosed in a sealed cover endorsed "Hayle Water Scheme—Tender for Contract No. 11—Phillack Towans Reservoir and Pipelaying" and addressed to the UNDERSIGNED and delivered not later than 10 a.m. on Monday, 30th January, 1961.

Only Tenders from firms experienced in this type of work will be considered.

The Board do not bind themselves to accept the lowest or any Tender.

E. O. WHEALE,
Clerk to the Board.

Municipal Buildings,
Penzance,
Cornwall.
16th December, 1960. E7442

Classified Advts. continued on page 54

EDUCATIONAL

A.M.I.MECH.E., B.SC., City and Guilds, &c., Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

AN ESTABLISHED, PROGRESSIVE, INDUSTRIAL CONCERN in SCOTLAND has vacancies for

DEVELOPMENT ENGINEERS

Applicants, aged up to 40, must have had at least ten years industrial experience and be qualified to A.M.I.Mech.E. standards. They should be men with initiative and ideas, able to design plant and equipment and follow up work to completed stage. Salary up to £1200 with contributory pension scheme.—BOX No. E3132, "The Engineer." A

ASSISTANT CHIEF ENGINEER required for Engineering Office on North East Coast. The work of the Company is connected with the design and construction of industrial power stations and general mechanical/electrification work and demands a knowledgeable and keen man between 35 and 45 years of age. The applicant must be a graduate or chartered mechanical/electrical engineer used to leadership and with a good experience in Contract work. Ability to work harmoniously yet firmly with existing staff is essential. Contributory Superannuation Scheme in operation.—Reply, giving full details of present salary and previous experience to BOX No. E7286, "The Engineer." A

ASSISTANT TO CHIEF ENGINEER required by Champion Sparking Plug Company Limited, Feltham, England, to maintain Technical Liaison with engine manufacturers throughout Europe. The work is interesting and varied and will involve considerable travel on the Continent. A good salary with all expenses will be offered to suitable applicant, aged about 30, who must have engineering degree or equivalent and preferably a working knowledge of some European languages. Practical experience on internal combustion engine development and use of associated test equipment is necessary. Written applications to Chief Engineer will be treated in confidence, and must give age, education, qualifications, experience, previous salary and recent photograph. E7433 A

BIRDS EYE FOODS LIMITED, GT. YARMOUTH

have the following vacancy :

LAYOUT ENGINEER GDS/15

The selected candidate will be responsible to the Factory Chief Engineer for the efficient operation of the Drawing Office. His duties will include process plant and packaging equipment layouts and preparation of installation costs. The position entails an amount of design work.

Previous applicants are being considered and need not re-apply.

Written applications from qualified men with experience in this field should be addressed to the Personnel Manager, Birds Eye Foods Limited, South Denes, Gt. Yarmouth.

E7427 A

CIVIL ENGINEERING ASSISTANT required in the London office of Norman & Dawbarn, Architects and Consulting Engineers, for Civil Engineering work associated with various building projects, including airports and factories. Age preferably between 25 and 35.—Written applications must give age, experience, qualifications and salary required, to : Norman & Dawbarn, 7, Portland Place, London, W.1. E3125 A

DESIGN DRAUGHTSMAN

An alert and intelligent Draughtsman with H.N.C. (Mechanical) or a young Graduate Engineer is required in the Drawing Office of an expanding Engineering Organisation in the transmission field, located in north-east England. This position is one of considerable scope and interest to a person of ambition. Age between 22 and 28 years. Salary to £900 for suitable applicant depending on age and experience. Superannuation and bonus schemes in operation.

Written applications in confidence to BOX No. E7436, "The Engineer."

A

DESIGNER DRAUGHTSMAN. Arthur Guinness Son & Co. (Park Royal) Ltd., have a vacancy on their permanent staff for an Engineering Draughtsman. Applicants, aged 28/35 years, should have at least a National Certificate in Mechanical Engineering, together with works and drawing-office training. Experience in design, and detail work in some of the following fields is essential : Chemical and process plants, services, refrigeration, plant layout, mechanical handling plant and general mechanical engineering. Commencing salary £950 to £1050, depending upon age and experience. Non-contributory pension scheme and excellent amenities.—Applications stating age, particulars of experience etc., should be sent in confidence to the Personnel Manager, Authur Guinness Son & Co. (Park Royal) Ltd., Park Royal Brewery, London, N.W.10. E7342 A

DRAUGHTSMAN required by the British Drug Houses Ltd., preferably with experience in Plant Layout and Special Purpose Machine Design. Must be able to take Site Dimensions. O.N.C. minimum qualification. Five-day week, Canteen, Sports Club, Pension and Profit Sharing Schemes.—Apply in writing, stating age, experience and salary required to the Office Staff Manager, Graham Street, City Road, N.1. E7430 A

SITUATIONS VACANT

ENGINEERING INSURANCE. Applications are invited from Mechanical Engineers not over 35 years of age, who having served an apprenticeship with Crane and Lift Makers have a sound theoretical and practical knowledge of Cranes, Lifts, Lifting Machines and their maintenance, and are qualified to Higher National Certificate Standard, for a vacancy as ENGINEER SURVEYOR based in the Stoke-on-Trent district. The position is permanent, pensionable, with salary scale of £825 rising to £1225 per annum, plus expenses and allowances.—Apply in own handwriting to BOX No. E7417, "The Engineer." A

ENGINEERING INSURANCE COMPANY invites applications from Engineers not over 35 years of age who possess First Class M.O.T. Certificate (Steam) for position as MECHANICAL ENGINEER SURVEYOR in Bristol and surrounding areas. Progressive salary scale commencing at £825 rising to £1225 per annum, plus other expenses and allowances. Non-contributory pension scheme.—Apply in own handwriting to The Northern Assurance Company Limited, 1, Moorgate, London, E.C.2. E7416 A

MAINTENANCE ENGINEER

A large manufacturing company has a vacancy for a Mechanical or Electrical Engineer to be engaged on the installation and maintenance of plant and machinery at its North Kent Works. Applications are invited from qualified engineers between 28 and 40 years of age with maintenance experience. The initial salary will be in the region of £1100 per annum, but more will be paid to a particularly well qualified or experienced engineer.—Apply, giving details of career and present salary to : The Chief Personnel Manager, BOX No. E7447, "The Engineer."

A

SENIOR DESIGN DRAUGHTSMAN required. Must be fully experienced in Hydraulic Engineering and general engineering design. State experience and salary required. Pension scheme and canteen facilities available.—Apply by letter marked : Technical Manager, The Hydraulic Engineering Co. Ltd., Chester. E7424 A

SIR WILLIAM HALCROW & PARTNERS

Consulting Engineers

require several ASSISTANT ENGINEERS with from 1 to 7 years' experience in civil engineering for Hydro-electric and other design work in their London offices.—Apply with full details of qualifications and experience to Alliance House, Caxton Street, London, S.W.1. E7379 A

THE GLACIER METAL COMPANY LIMITED

Manufacturers of Plain Bearings,

have a vacancy in their Licensing Department for an

ASSISTANT LICENSING ENGINEER

The Licensing Department is concerned with liaison with overseas manufacturers who are licensed to use Glacier manufacturing processes and techniques.

The A.L.E'S work will be concerned with providing licensees with data on the Company's manufacturing processes, interpreting licensees' requirements, showing visitors around the factories explaining techniques and processes, &c.

Applicants must have a sound engineering knowledge of at least H.N.C. standard and previous experience in the field of production engineering. Alternatively, a young graduate mechanical engineer with one or two years industrial experience might fit in this role.

Candidates must be able to speak and write clear, concise English ; knowledge of French and/or German would be an asset but is not essential.

Minimum age 25 years. The salary is in the range of £950 to £1350 per annum. Send brief, relevant details, quoting Ref. HQPD/ALE, to Personnel Division, The Glacier Metal Company Limited, Alperton, Wembley, Middx.

E7426 A

MILLARS'
MACHINERY COMPANY LIMITED

invite applications for the position of

DESIGN DRAUGHTSMAN

for Development work on Hydraulic pumping equipment

This position offers excellent opportunities for a man with suitable experience.

A Pension Fund and Life Assurance scheme is in operation.

Apply in writing giving details of age and experience to:

Personnel Manager,
MILLARS' MACHINERY CO. LTD.,
Thorley Works, Bishop's Stortford, Herts. E7409 A

SITUATIONS VACANT

ENGINEER WITH INITIATIVE

Required by a North-East Coast Engineering Firm established in the Mechanical Transmission Field. This position involves responsibility for the design and development of Gear and Transmission Units and offers scope and interest to an Engineer who is keen to progress along the technical executive path of an expanding organisation.

Applicants must have reached H.N.C. (Mechanical) standard or equivalent and have experience of transmission Applications, preferably in the steel industry and/or the cement and rubber industries.

Initial remuneration of up to £1200 according to age and experience. Superannuation, bonus and house assistance schemes are in operation. Written applications in confidence to BOX No. E7435. "The Engineer." A

SITUATIONS VACANT

HOWDEN

James Howden & Company, Limited have vacancies for

MANUFACTURING DEVELOPMENT ENGINEERS

The Company are manufacturers of industrial fans, preheaters, precipitators, dust collectors, compressors, turbines etc., and these engineers are required to study problems arising in Fabrication, Press-Work, Machining and Assembly of these products. Applicants should be of degree standard, and graduates or members of a professional institution. The ability to write clear concise reports is an essential qualification. The posts offer good prospects of advancement for young engineers with drive and ability.

Apply Personnel Manager, James Howden & Company, Limited, 195, Scotland Street, Glasgow, C.5., giving full details of career to date. E7439 A

LAPORTE CHEMICALS LIMITED

(a member of the Laporte Group of Companies)

Require SENIOR

MECHANICAL ENGINEERING DRAUGHTSMEN

for interesting work on large chemical plant installations. Experience in the type of work is desirable but not essential and applicants with general mechanical engineering experience will be favourably considered. The posts offer opportunities and salaries consistent with experience and ability. Modern offices situated in the London E.C.4. area. Five-day week and superannuation scheme.

Applications, which will be treated in the strictest confidence, giving details of age, qualifications and experience and quoting ref. LCL/TE2/1 should be addressed to The Group Personnel Manager, Laporte Industries Limited, Hanover House, 14, Hanover Square, London, W.1.

E7423 A

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED

Applications are invited for the following positions in the Nuclear Power Division which is responsible for the installation of Propulsion Machinery in Nuclear Submarines.

TECHNICIANS

for thermodynamic, heat balance and general stress work. Candidates should have a Degree or good H.N.C.

DRAUGHTSMEN

for machinery and pipe system arrangement work. Candidates should have O.N.C. or M.O.T. Certificate as minimum qualification and drawing office experience on Marine work is desirable.

DEVELOPMENT ENGINEERS

for work in connection with investigating improved methods of design for production and installation. Candidates should have H.N.C. as minimum qualification and appropriate experience.

These positions offer scope for advancement in a new and expanding department.

Successful applicants will be required to join the Company's Contributory Superannuation Scheme when eligible.

Applications, which will be treated in strictest confidence, should give full details of age, qualifications and experience and current salary and be addressed to:—

The Manager, Nuclear Power Division,
VICKERS-ARMSTRONGS (ENGINEERS) LIMITED
Naval Construction Works, Barrow-in-Furness, Lancashire.

E7349 A

SITUATIONS VACANT

SKETCHLEY LIMITED

require a

WORKS ENGINEER

for their main works at Hinckley, Leicestershire.

Applicants must have technical qualifications and experience to carry responsibility for all engineering services, including steam raising (120,000 lb/hour capacity coal fired water tube boilers), power generation (2150 KW. capacity), and the installation and maintenance of process plant (dry cleaning and hosiery dyeing and finishing). The Works Engineer is responsible for a staff of approximately 60 tradesmen etc.,

The position is permanent and pensionable, and an attractive salary is offered. Assistance with housing.

Applications should be addressed to Chief Engineer, Sketchley Ltd., Hinckley, Leicestershire.

E7415 A

SITUATIONS VACANT

PLANT ENGINEER/MANAGER

to take charge of specialist service in North East. Construction experience an advantage.

Duties include commercial and technical supervision and call for self reliance and initiative.

Excellent opportunity to develop by own efforts with full backing.

Salary to commence £900.

Bonus, Car, Superannuation, etc.

Fullest details in strict confidence to Box No. E7422, "The Engineer."

A

SITUATIONS VACANT

SENIOR PROJECT ENGINEER

required for the Central Engineering organisation of an active and flourishing Chemical concern in the North of England with international interests.

The duties attached to the post are the direction and co-ordination of the engineering activities of a group of projects concerned with the Company's expansion at home and overseas. The post is primarily concerned with design and procurement and not directly with site work.

A wide engineering experience is essential, including Civil, Electrical and Instrument engineering, with emphasis on Mechanical Engineering Design and Chemical Plant layout.

Applicants must be University graduates in Mechanical/Electrical Engineering and have served an apprenticeship, followed by at least ten year's experience in the Chemical industry.

A salary of the order of £2,500 is offered and interested Engineers who fulfil the above qualifications may write in strictest confidence to BOX No. E7405, "The Engineer." A

Brush Electrical Engineering Company Limited
Loughborough, Leicestershire

(A member of the Hawker Siddeley Group — Industrial Division)

INDUSTRIAL APPLICATIONS ENGINEER

Due to expansion in the industrial applications field this Company has a vacancy for a Senior Engineer in the Industrial Application Section of the Electrical Rotating Machines Engineering Department. A knowledge of drives in the rubber, plastics and associated industries and of related control systems is essential. Some practical experience of site testing and commissioning is also desirable.

Applications are invited from fully qualified men and preference will be given to corporate members of the Institution of Electrical Engineers.

Applications, WHICH WILL BE TREATED IN THE STRICTEST CONFIDENCE, should contain brief details of experience and qualifications and should be addressed to Mr. P. A. McCaig, quoting reference: PL.9904.

Brush Electrical Engineering Company Limited
Loughborough, Leicestershire

E7368 A

LIL

LAPORTE CHEMICALS LIMITED

(a member of the Laporte Group of Companies)

require

SECTION LEADERS

for interesting work on large chemical plant installations. Candidates aged between 30 and 40 years should be experienced in plant layout and vessel design and familiar with British and American Codes of Practice. They should be first-class men of H.N.C. Standard, capable of controlling a section of draughtsmen and working under the direction of a Project Engineer.

The positions are permanent and attractive salaries will be offered to the selected applicants. Modern offices situated in the London E.C.4. area. Five-day week and superannuation scheme. Applications will be treated in the strictest confidence.

Details of age, qualifications and experience, and quoting reference LCL/TE2/82 should be sent to the Group Personnel Manager, **LAPORTE INDUSTRIES LIMITED,** Hanover House, 14 Hanover Square, London, W.1. E7411 A

VICKERS-ARMSTRONGS (ENGINEERS) LTD.

BARROW-IN-FURNESS, LANCASHIRE

invite applications for the following positions :

HEALTH AND SAFETY OFFICER

SENIOR HEALTH PHYSICIST

These are senior appointments and the salary offered will be in accordance with the qualifications and experience of the candidate. The Health and Safety Officer will be responsible for organising the setting up of a Health Physics Department, the preparation of procedures covering all activities involving the movement, storage and operations involving nuclear materials, and ensuring that such procedures are carried out. He will be responsible for conducting all negotiations between the firm and the various Ministries and Local Authorities.

The Senior Health Physicist will be responsible to the Health and Safety Officer for all Health Physics measurements within the works and for the calibration and maintenance of Health Physics equipment.

The Company operates a Contributory Pension Fund and applications giving full details should be sent to The Manager, Marine Propulsion and Development Department at the above address.

E7403 A

F. PERKINS LIMITED

Diesel Engine Manufacturers, Peterborough

The F. Perkins Group of Companies wish to make the following appointments :

★ **RESEARCH & DEVELOPMENT ENGINEERS** for experimental work on internal combustion engines. Two to three years experience of this type of work is desirable and applicants should be of H.N.C. standard.

★ **ELECTRICAL DEVELOPMENT ENGINEERS** for developing electronic and electrical instruments for use on High Speed Diesel Engines. A general knowledge of internal combustion engines is desirable. Applicants should be of H.N.C. standard or G.I.E.E.

★ **ENGINE DESIGNERS & DESIGN DRAUGHTSMEN** with experience of design of high speed engines for vehicles, tractors etc., H.N.C. desirable *but not essential.*

★ **SENIOR JIG & TOOL DESIGN DRAUGHTSMEN** with experience of all types of mass production tooling. O.N.C./H.N.C. qualifications desirable but not essential for right type of man with suitable workshop training.

★ These appointments will carry attractive salaries commensurate with age and experience. Good conditions include Pension and Assurance Schemes and three weeks holidays, and assistance towards house purchase may be given.

Applications giving full details, to Manager, Personnel & Industrial Relations Division, quoting reference E.D.4.

E7448 A

Classified Advts. continued on page 56

SITUATIONS VACANT

KING EDWARD'S SCHOOL
WITLEY,
NR. GODALMING,
SURREY

ASSISTANT ENGINEER

required at co-educational boarding school.

Must be a qualified electrician and experienced in the running of oil-fired plant. Knowledge of institution maintenance work and kitchen plant an advantage.

Cottage available.

Salary £590 p.a. rising to £620 p.a. Contributory superannuation scheme.

Apply giving full details of age, experience, etc. to The Bursar.

E7408 A

CRANE MANAGER

required

for N.E. Regional Office by large company operating fleet of LORRY MOUNTED CRANES. Applicants must have :—

Experience in control of labour, Ability to negotiate with customers. Commercial experience in plant or crane hire. Initiative, self reliance and personality to represent the company adequately.

Commencing salary £900-£1100 depending on experience. Bonus, Car, Superannuation Scheme etc.

Excellent prospects for an ambitious man in an expanding business. Replies in confidence to BOX No. E7421 "The Engineer."

A

HOWDEN

James Howden & Company, Limited, have a vacancy for a

WELDING DEVELOPMENT ENGINEER

This is a new appointment and candidates should have industrial experience of modern welding techniques and application, automatic and semi-automatic processes, supervision of welding, modern destructive and non-destructive examination, ability to organise weld investigation and determine welding procedure, to test welder personnel. Membership of a Professional Institution is desirable and applicants should be of potential managerial calibre. Good salary and conditions of service.—Apply Personnel Manager, James Howden & Company, Limited, 195, Scotland Street, Glasgow, C.5, giving full details of career to date.

E7440 A

SENIOR DRAUGHTSMAN

A Company situated in E. London manufacturing insulated wires for industry invite applications for the above post. The successful applicant will work in a development drawing office on the design of special purpose plant for the production of insulated wires.

It is preferred that candidates should possess H.N.C. (Mech). The post is pensionable and the commencing salary which will be dependent upon age, qualifications, and experience will be in the range of £900 per annum. Applications should be addressed to the Personnel Officer, The London Electric Wire Company and Smith Limited, 210, Church Road, Leyton, E.10. LEY 3636. E7434 A

SITUATIONS FILLED

APPLICANTS TO "BOX NUMBERS" HAVE NO MEANS OF DISCOVERING WHETHER THEIR APPLICATIONS HAVE BEEN REJECTED OR MAY STILL BE UNDER CONSIDERATION. IF "BOX NUMBER" ADVERTISERS WILL ADVISE US WHEN A SITUATION HAS BEEN FILLED, WE SHALL BE PLEASED TO PUBLISH FREE A NOTE TO THIS EFFECT WITHOUT DISCLOSURE OF THEIR NAME.

SITUATIONS WANTED

M.I.MECH.E., M.I.E.E. SEEKS DIRECTORSHIP. Wide experience at home and abroad.—BOX No. E3114, "The Engineer." B

ENGINEER, 37 (English), B.Sc., A.M.I.Mech.E. Experienced maintenance and construction of chemical and food plants, seek position abroad : Europe, North Africa or N.Z.—BOX No. E3131, "The Engineer." B

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft by 6ft or 6ft diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

RESEARCH DESIGN and DEVELOPMENT

NORRIS BROS. LTD.,
53 VICTORIA ST., LONDON, S.W.1.
Tel.: ABBey 6132,
and at Burgess Hill, Sussex,
Specialists in
RESEARCH, DESIGN, DETAILING AND DEVELOPMENT
throughout the whole of the Engineering Industry
E194 RD

PATENTS

THE PROPRIETOR of British Patent No. 755082, entitled "SUBSURFACE WELL TOOLS," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A. E7429 H

FOR HIRE

MOBILE LIFTING SERVICE. Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.—MOBILE LIFTING SERVICES LTD., A member of the TARMAC Group, Rotherham 78481. E186 K

FOR IMMEDIATE HIRE

1959 model 607 RECORD TOWER CRANE

Capacity : 3 tons @ 28 ft.
1 ton @ 82 ft.

Complete with all ancillary equipment.

CHAMBERLAIN PLANT LIMITED,
Crown Works, Southbury Road, Enfield, Middlesex.
Tel.: HOWARD 4994

E7345 K

MISCELLANEOUS

DAVIES INVESTMENTS LIMITED
BANKERS
(Gross assets £2,000,000), are paying 7½ per cent. p.a. interest on deposits for the seventh year in succession, with ¼ per cent. added annually on each £500 unit.—Details and Audited Balance Sheet from : Investment Dept. ER.
DAVIES INVESTMENTS LTD.
DANES INN HOUSE, 265 STRAND,
LONDON, W.C.2.
E178 I

MACHINERY Etc. WANTED

HEENAN & FROUDE DPX4 DYNAMOMETER. State condition, where seen and price.—BOX No. E3128, "The Engineer." F

VERY URGENTLY REQUIRED TO PURCHASE
ONE RUSTON 22W or 22RW WELL DRILL. Full details to : Vales Plant Register Ltd., 14, Lower Grosvenor Place, London, S.W.1. VICtoria 7531. E108 F

URGENTLY REQUIRED : 3 High Pinion Box Rolling Mill, approx. 23in./27in. centres.—Please send full details and price required to BOX No. E7444, "The Engineer." F

URGENTLY REQUIRED : Heavy Duty Bull Block capacity up to 1½in. Mild Steel, with electrics for 400/440V, 3 ph., 50 cycles.—Full particulars &c., to BOX No. E7445, "The Engineer." F

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochran Vertical (New) 7ft. and 6ft. 6in. dia., 150 lb. w.p.; reconditioned 9ft. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstubes, all sizes.
AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several other of various makes and capacities.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.
MOBILE ROAD CRANES.—10-ton Lorain lorry-mounted 30ft.–70ft. extendible jib ; 8½-ton Ransome Diesel/Electric 21ft. jib ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids, 1945 ; 3-ton Jones "Super 40" diesel, pneumatics (3).
OVERHEAD CRANES.—25-ton Girders and end carriages, with 60 h.p. motors, 95ft. 10in. span ; 25-ton Clyde, 21ft. 9in. span, new 1954 ; 20-ton Vaughan, 42ft. 3in. span, unused (2) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 10-ton Heywood, 34ft. span, unused ; 10-ton Morris, 32ft. 10in. span, 400/3/50 ; two 10-ton, 60ft. span, 1955 ; two 7-ton, 37ft. span, 1950 ; Wharton, 7½-ton 25ft. span, 400/3/50 ; 5-ton, 37ft. span, 1944 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V d.c.
DERRICK CRANES.—7-ton Henderson, 110ft. jib, electric, 1952 ; 7-ton Anderson-Grice, 100ft. jib, electric ; 5-ton Butters Grabbing, 80ft. jib, electric ; 5-ton Wilson, 70ft. jib, electric ; 3-ton Smith, 48ft. jib, electric ; 3-ton Rushworth, 50ft. jib, hand ; 15-cwt. Anderson-Grice, 30ft. jib, hand.
RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Grafton, 34ft. jib, diesel conversion ; 8-ton Wilson, steam, 35ft. jib ; 5-ton Smith, 50ft. jib (2).
LOCOS.—Fowler diesel, 150 h.p. (2) ; Barclay & Ruston, 80/88 h.p. diesel ; Bagnall, 14in. by 22in. (two oil-fired, one coal), Peckett steam, 7in. by 12in., 1941 ; 4 Logan battery-operated, 24in. gauge, 3-4-ton cap.; 3 Ruston diesel 16/20 h.p., 24in. gauge ; also 2 miles 20 lb. and 1200 yds. of 23 lb. by 24in. gauge track, Bogies, Wagons, &c.
STEEL PIPING.—Large stocks including following ; 20,000ft. 1¼in. galvanised "A,"; 20,000ft. scaffolding ; 30,000ft. 3in. black ; 15,000ft., each 6in., 3/16in., ¼in., 5/16in., unused ; 5000ft., 8in. unused ; 2000ft., 10in., 12in., 16in., seamless ; 200ft., 24in. by ¼in. welded, unused ; 1000ft., 30in. by ¼in. welded, unused ; 2500ft., 27in. welded flanged ; 500ft., 36in., unused ; 500ft., 42in. by ¼in. riveted ; 100ft., 48in. by ¼in. welded, unused ; 150ft., 60in., welded ; 20in., 24in., 26in., 27in., 28in., bitumen-lined, unused. Full list on request.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s., including 150 by 18ft. lengths, 6in. Stanton class "B" Spigot and Socket, unused. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot. New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular, up to 12,000 gallons for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.
MACHINE TOOLS.—Heenan & Froude Dynamometers, 1500 h.p. maximum, 18in. Dial Indicator (three) ; Pels Punch and Shears, ¾in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; Berry Guillotine capacity 4ft. by 1in. ; Rushworth Guillotine, 6ft. by ¼in., Bliss 70-ton power press ; 3 Bliss No. 304 vertical single action drawing presses, 7½in. stroke ; 7ft. by 1in. Plate Flattening Rolls ; 9 roller flatteners, 2ft. by ¾in. capacity.
AUTOCLAVES.—Two 26ft. by 9ft. dia. hinged doors ; new 1948, about 45 lbs. working pressure ; jacketted, autoclave, 12ft. by 7ft. diameter, bolted lid, approx. 60 lbs. steam pressure.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
Phone : Coleford 2271/2 E106 G

TWW

TWO "COLES" DIESEL/ELECTRIC RAIL SHUNTING CRANES, powered by "Perkins" P4 diesel engines, fitted 50ft. Swan Necked Jib, extended four wheel carriages for shunting purposes, the Cranes new 1951 and in good order throughout.—Further particulars from : THOS. W. WARD LTD., Albion Works, Sheffield. 'Phone : 26311. Extension 287. E216 G

FOR SALE

Edwards

RHODES Open Fronted Upright Bench Punching Press, motorised for 400/3/50 supply, pressure exerted approx. 2 tons, stroke ¼in., adjustment to table 2in., table 9in. by 4¼in., hole in table 1in. by 3in., weight approx. 3¼ cwt.
FROST Power Geared Swing Beam High-Lift Universal Folding Machine, motorised for 400/440/3/50 supply, capacity 10ft. by 3/16in. mild steel, adjustable for sharp and round bends, clamping beam swings out for removal of trunk sections, with adjustable back gauge, weight approx. 6 tons.
PELS Double Ended Universal Punching, Shearing and Section Cropping Machine, motorised for 400/440/3/50 supply, punches up to 1⅛in. diameter by 1in. thick, depth of punch gap 24in., shears flat bars up to 1in. thick, crops rounds, tees, squares and angles in proportion, weight approx. 8 tons.
PELS Double Geared All Steel Double Ended Angle and Tee Iron Cropping Machine, motorised for 400/3/50 supply, on turntable base for positioning in any direction, crops angles 7in. by 7in. by ½in. or 6in. by 6in. by ⅝in., tees 6½in. by 6½in. by ½in., on the square and on the bevel, weight approx. 105 cwt.
CRAIG & DONALD Deep Gap Guillotine Shearing Machine, motorised for 440/3/50 supply, with automatic hold-down and adjustable back gauge, capacity 14ft. by ¼in., complete with three spare sets of blades, weight approx. 11 tons.
HAMILTON No. 45, Double Sided Power Press, motorised for 400/3/50 supply, pressure exerted approx. 100 tons, stroke 5in., between uprights 42½in., bed 42in. by 32in., hole in bed 33in. by 20½in., weight approx. 8 tons.
TAYLOR & CHALLEN Double Sided Double Action Cam Action Drawing Press, punch stroke 8in., blankholder stroke 4in., between uprights 20in., bed 18in., by 15¼in., hole in bed 8in. diameter, punch 4in. diameter, hole in punch 1¾in. diameter, weight approx. 45 cwt.
Photographs of the above are available.
Very favourable Hire Purchase terms can be obtained.
MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.
359-361, EUSTON ROAD,
LONDON, N.W.1.
Telephone : EUSton 5000 Telex 24264
And at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone : Central 7606-8. E207 G

HYDRAULIC PRESSES
200-ton Fielding, 42in. stroke, 63in. daylight (five off).
100-ton Fielding, 72in. stroke, 99in. daylight.
50-ton Fielding, 24in. stroke, 48in. daylight.
200-ton Tangye Vertical open fronted, 21in. stroke, table 24ft.
80-ton Musgrave Vertical upstroke, 42in. daylight, platens 72in. diameter.
Fielding Horizontal, 24in. stroke, bend up to 8in. pipes.
All complete with pumps and motors.
FRED WATKINS (ENGINEERING) LTD. COLEFORD, GLOS.
'Phone Coleford 2271/5. E193 G

FOR SALE
One 1939 Herbert type "O" 4-spindle DRILLING MACHINE with D.C. motor, belt driven spindle.
One 1935 Adcock and Shipley 3-spindle SENSITIVE DRILLING MACHINE with D.C. motor.
One 1939 "Richmond O-3" HORIZONTAL MILLING MACHINE with Arbor D.C. motor.
One 1946 Cincinatti 1/18 production type HORIZONTAL MILLING MACHINE complete with change gears, A.C. motor.
One 1945 Archdale 20in. PLAIN HORIZONTAL MILLING MACHINE complete with auxiliary vertical head and Arbor A.C. motor.
One 1919 Rhodes FLY PRESS.
One 1943 Denbigh KICK PRESS.
Offers invited. Reply to : Reference CB/1, Crompton Parkinson (Chelmsford) Ltd., Chelmsford, Essex. Telephone : 3161. E7410 G

PLANERS LTD. DOUBLE-SIDED HORIZONTAL PLANER
Table 8ft. by 2ft. 2in. Admits between sides 2ft. 6in. and under toolboxes 2ft. 6in. approx. Two toolboxes on cross beams. Rack and pinion drive to table. V-bed.
H. BELL (MACHINE TOOLS) LTD.,
WALTER STREET, LEEDS, 4.
Tel.: 63-7398.
E105 G

FOR SALE
CENTRELESS BAR TURNING MACHINE by Kieserling & Albrecht, capacity 2in. minimum, 6in. maximum, complete with electrics. In "as new" condition.—BOX No. E7305, "The Engineer." G

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GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
1961			
January 4	**Miscellaneous stores.**	**Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.**	**BARTLE & SON** (Dept. L), 30-52, Merrion Street, Leeds, 2. (Tel.: 20898.)
January 11	**Machine tools and miscellaneous stores, including:**	**Central Ordnance Depot, Tidworth. Central Ordnance Sub-Depot, Devizes. (Sale at Corn Exchange, Devizes.)**	**FARRANT, WIGHTMAN & PINNIGER** (Dept. L), Market House, 2, Newport Street, Swindon. (Tel.: Swindon 5151/2.)
	Lathes; horizontal milling machine; grinding and drilling machines; valve refacing machines; welding plant; electric travelling hoist; charging plant; generators; lifting gear; winches; water sterilisers; accelerators; M.T. spares; paint spraying machines; paint; electric cable, stores and equipment; protective wax spraying solution; tool kits; hand tools; tarpaulin covers; canvas; bedding; greatcoats; drawers; shirts; portable cooking stoves; motor mowers; tables; chairs; furniture; mirrors; cutlery; crockery; kitchen utensils etc.		
January 19	**Miscellaneous stores.**	**W.D. Storage Depot, Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
January 27	**Miscellaneous stores.**	**Command Ordnance Depot, Coypool, Marsh Mills, Plymouth. (Sale at Kinterbury House.)**	**WOOLLAND SON & MANICO** (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 69292.)
February 1	**Machine tools and miscellaneous stores.**	**Technical Stores Depot, Old Dalby, Leics. (Sale at Melton Mowbray.)**	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
February 7–9	**Vehicles, earth-moving equipment, mobile cranes and motor cycles.**	**W.D. Storage Depot, Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
February 10	**Miscellaneous stores.**	**Returned Stores Group, Reed Hall, Colchester, Essex.**	**FENN WRIGHT & CO.** (Dept. L) 146, High Street, Colchester, Essex. (Tel.: 73171.)
February 14–15	**Machine tools and miscellaneous stores.**	**W.D. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
February 28	**Miscellaneous stores.**	**1 E.S.D., Long Marston, Nr. Stratford-on-Avon, Warwicks. (Sale at the Hippodrome, Stratford-on-Avon.)**	**LOCKE & ENGLAND** (Dept. L), 166, Parade, Leamington Spa, Warwicks. (Tel.: 2833.)

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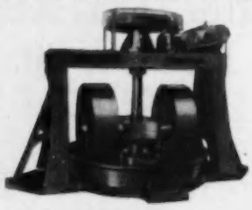

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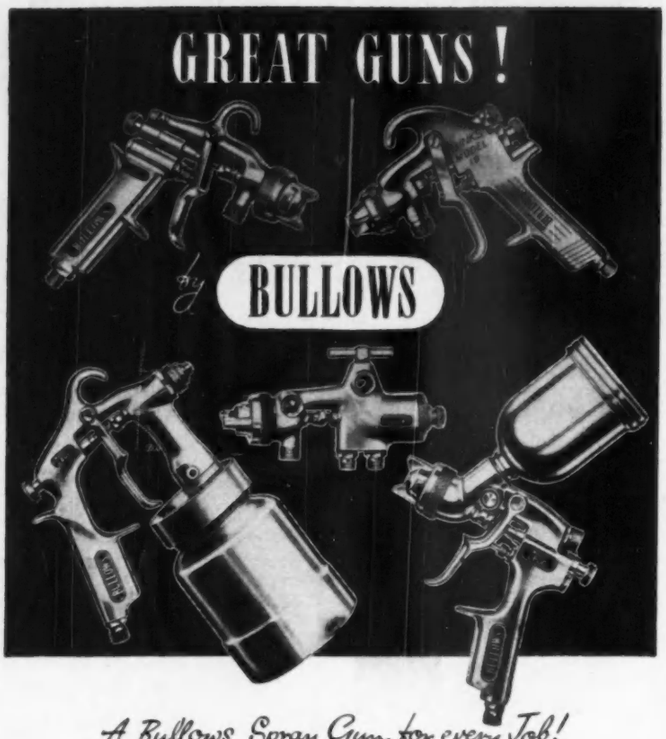

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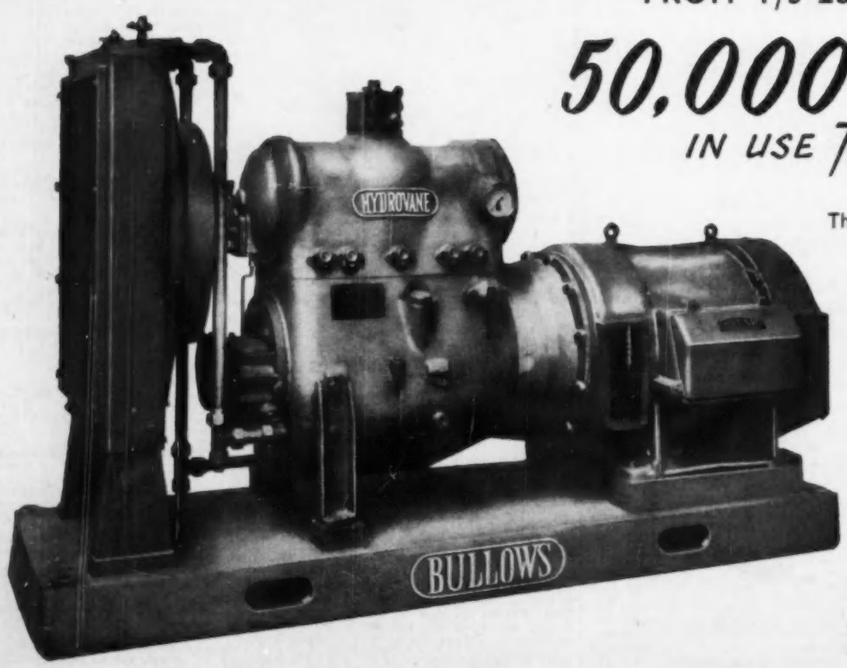

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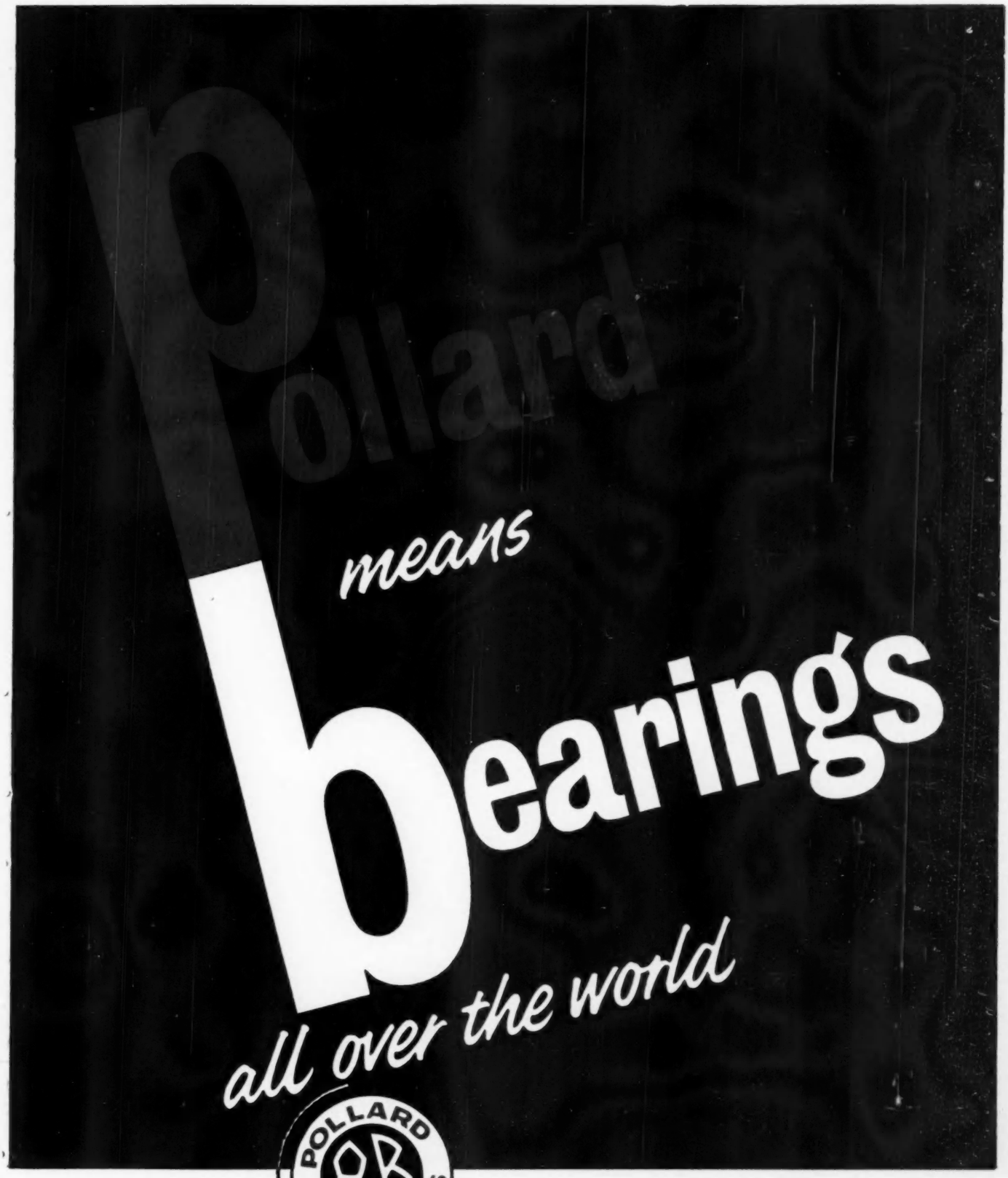

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